

	U.C. Irvine Process Group		Process Technologies			Workflow Technologies			Groupware, Collaboration, and Communication Technologies				MIS Systems	Project Management.	Others			
	Endeavors-1.0.7	Endeavors-1.1+	OzWeb	SPADE	CapWeb	FileNet Visual Workflo	Xerox/Xsoft, InConcert 3.5.2	Action Technologies Metro 3.0	BSCW 3.0.1	Lotus Notes Domino (4.6b)	Netscape Collabra	Microsoft Exchange	PeopleSoft Workflow/Tools	iCAT Electronic Commerce 3.0	Microsoft Project 4.2	Visio Professional 4.5		
Overview	Contact Information	endeavors@ics.uci.edu	endeavors@ics.uci.edu	kaiser@cs.columbia.edu	fuggetta@elet.polimi.it	weaver@cginm.cps.fr	product_info@www.filenet.com (800) 345-3638	InConcert, Inc., 800-367-9248; Xerox New Enterprise Company	Action Technologies, Inc. +1-510-521-6190, 800 -WORKFLOW	bscw@gmd.de http://bscw.gmd.de/Feed-back.html	domino_server@lotus.com	Netscape Corporate Sales: 415/937-2555	Microsoft Corp. One Redmond Way, Redmond WA 98052	PeopleSoft marketing (888) 773-8277	iCAT (888) 533-8800; more-info@icat.com	Microsoft Corp. One Redmond Way, Redmond WA 98052	Visio Corp. (800) 248-4746, esdirect@visio.com	
	Description	WWW-based, lightweight workflow infrastructure with flexible execution and modeling	WWW-based, lightweight workflow infrastructure with flexible execution and modeling; Extensive automation, guidance, reuse, and configuration support	Flexible rule-based process modeling execution engine w/ distributed tool support and interactive negotiation.	Process centered software engineering support environment w/ collaboration interface, formal process modeling language, execution infrastructure	WWW-based port of process formalism, graphical process notation, backend server, and client support including frames, javascript, and agenda management.	Flexible workflow engine with graphical process design, triggers, agents, and document management capabilities; templates	Flexible workflow engine with graphical process design, triggers, agents, and document management capabilities; templates	Browser based workflow product, automation and status; open standards, graphical workflow builder, application server and suite of integrated collaboration tools	Basic support for Cooperative Work collaborative tool boards, email, and WWW views and manipulation of data	Cross-platform application client and server w/RDBMS, group boards, email, and WWW views and manipulation of data	Intranet based mail and messaging; groupware system including client supports rich content; integration with calendar and directory services	Network based messaging system including support for transactions, recovery, views, filters, and triggering of actions on inputs	Business process automation tool with flexible execution, development tools, and architecture that supports distribution.	Domain specific intranet software for specifying electronic commerce processes and series of WWW interactions	Project management and planning software with analysis, metrics, calendaring, and resource management	Full featured diagraming and drawing tool with flexible graphics sets	
	Best Attributes	Lightweight, customizable, flexible, reflexive, dynamic; Ease of integration; multiple process and execution models	Distributed application dev. support; replication, constraint & relations management; scalability	Transaction support, flexible execution engine, changing, pre- and post-conditions, constraints	Flexible, virtual machines architectural allows for decoupled user workspaces, CSCW, and robust process modeling and analysis, some dynamic state and process change management.	Built using Process Weaver engine (first commercial available execution engine), extensible.	Robust workflow engine with graphical process description & editing; database integration w/ triggers and automation capable; document management	Robust workflow engine with graphical process description & editing; database integration w/ triggers and automation capable; document mgnt	Tools for system integration and rapid build and deployment of processes on intranet and extranets; email, calendar, workbook and views	Dynamic, extensible collaboration server; visual event representations; document versioning	Application development environment & deployment server; replication, security, & remote collaboration	Open, internet-based groupware solution; collaboration tool easily deployed and accessible; corporate knowledge-base including content	Broad support for network protocols, good group management, scheduling, replication, routing, distribution	support for tailoring the tools and rapid application development; flexible messaging.	Extensible language for building apps; Reusable templates; internets-based sales tracking, status, updates/query	Cost, time, & resource budgeting, critical path identification, analysis	Widely used, strong support for non-technical users, complex diagrams, process design	
Availability	Most Telling Criticisms	Research in progress; robustness, no fixed end user model or architecture	Research in progress	Rule-based processes require tech expertise to build/change; difficult to visualize, manage large ruleset	Petri-net derived process model graphical, but difficult to understand, develop processes; componentized, but heavy-weight infrastructure; minimal deviations	Some hierarchical process support; CoShell programming required for integration; minimal artifact modeling	No incremental adoption/development; high maintenance, limited cross-platform, graphical semantics ambiguous; lacks exception handling; closed system	No incremental adoption/deployment; high maintenance, limited cross-platform, graphical semantics ambiguous; lacks exception handling	No incremental adoption; fixed deployment architecture; lacks evolution and build-in model	Weak workflow semantics; uses messages and calendar/schedule only, no explicit or built-in model	Weak workflow semantics; uses messages and calendar/schedule only, no explicit or built-in model	No workflow design tool, functionality built via RAD visual C++ development, no built-in forms, views, process, roles, or rule support	Limited evolution capabilities and dynamic workflows are delivered applications, post deployment changes difficult	Inflexible, no tool integration, changes to process require re-deployment; n/a for general workflow, limited to e-commerce	No execution, no integration of external tools; limited control flow; difficult consistency	No semantics, no execution, no integration of external tools, difficult to define common representations		
	Cost	Free	Free	Free or Nominal	Free (req O2 database, ~10K)	~\$20K first seat	~\$500/seat; +RDBMS	~\$500/seat; +RDBMS	~\$150 to \$1,500/seat	Free	~\$69/\$495/\$1.4k/	~\$295-\$4,995	~\$66/user/(clnt + srvr)	starts \$100K/applc.	\$3,495-\$9,995	under \$500	under \$200	
	Platforms	100% Java, designed for platform independence & interoperability, including JavaStation NC	100% Java, designed for platform independence & interoperability including NC, PDA and wireless.	Unix and some Windows NT support; WWW clients	DEC 5000 under Ultrix 4.2, Sparcstations under SunOS	RS/6000 or Sun backend, WWW clients	Clients Windows, Server Solaris, AIX, HPUX, and Windows NT	Server and Client, Solaris, AIX, HPUX, and NT uses Windows 3.1/95/NT clients	Windows 95/NT, client browser-based	RISCs 3.1/95/NT, MacOS, and most unix systems; client browser-based	Windows 3.1/95/NT, MacOS, and most unix systems	Windows NT, and most unix system; client browser-based	Windows 95/NT/others, NT RISC-based systems including PC604 and DEC Alpha	Cross-platform support; most business desktops and servers.	Development on Windows 95/NT; target host Solaris, Irix, Windows, & others	Windows 95/NT/others, MacOS	Windows 95/NT, earlier products 3.11	
Background	Terms and Conditions	Public domain w/ copyright.	Public domain w/ copyright.	Public domain w/ copyright	Unknown status, university copyright	Unknown status; bundled with commercial product	Commercial product	Commercial product	Commercial product	Public domain w/ copyright	Commercial product	Commercial product	Commercial product	Commercial product	Commercial product	Commercial product	Commercial product	
	History	Software PML research (Teamware, Appia), SEE's, sSEE's; 2nd generation Process Centered Environment; UCI/DARPA funded research	PML research (Teamware, Appia), SEE's, sSEE's; next generation Process Centered Environment; UCI/DARPA funded research	SEE's, PML's, (Marvel, OZ) Columbia University/DARPA funded research	SEE's, PML's, (Slang), CSCW ImagineDesk, research done at Politecnico di Milano, Italian National Research Council funded and DEC	Process Weaver modeling environment, graphical workflow editor; targeted business process community; Cap Gemini, France	Image processing and document management software expanded for document routing; tools and workflow engine, status	Workflow engine in business process domain targeting solutions for telecom, high-tech manufacturing, and engineering.	Enterprise Workflow engine extended to the intranet/extranet; development tools targeted to workspace development and some business domains	Cooperative work using the WWW; synchronous groupware; collaborative info sharing; workspaces, versioning	Personal Information Management system extended to groupware and groupware, cross-platform network collaboration	WWW server expanded to news, messaging, email, and content management, calendaring, and directory services	Cross-network email system extended to messaging and groupware including replication, scheduling	Human resources management tool; expanded into purchasing including shopping cart, tax, shipping; component architecture & dev tools	Electronic commerce; package for online purchasing including shopping cart, tax, shipping; component architecture & dev tools	Project planning software for PERT/Gantt charts. Critical path analysis and workload status visualization	Drag-and-drop diagramming tool for non-technical users, expanded to business domains	
	Product Trajectory	Dnd customization, integration; increased support for non- and semi-technical users	support for complex reusable processes in online marketplace; easier domain specific customization	Componentization and flexibility; increased support for dynamism and process evolution	User-oriented processes, formalism to describe both process and results, heterogeneous, concurrent, distributed process architecture, analysis, evolution	Process modeling and execution engine re-targeted for the WWW; Ecommerce, Agent support, customer tracking and tracking	Rapid workflow development and customization; integration of ad-hoc and enterprise processes; automation and tracking	Rapid app to target domains; integration; support for active workflows and capture, better distribution	Improved end-user and non-technical specify and program & deployment of processes on an intranet; ad-hoc collaboration; architectural abstraction	MetaWeb; Access control; Java UI components; workspaces as Web sites, threaded discussions, code, security	Tight integration with the WWW, support for java components, development tools, application templates	Tight integration with the WWW and tools; evolve to support virtual workgroups and content delivery dataflow	Extension to workflow domain incl. WWW, Java front-ends, ActiveX components for electronic forms based dataflow	Globalization and tailoring; custom enterprise & markets; distributed publish/subscribe messaging planned	Development of software products & technologies to rapidly create consumer and business-to-business purchasing channels	Increased support for task notification through email and other communication; what-if project scenarios, risk analysis.	Increased support for non-technical diagramming as medium for idea interchange & visualization	
	Time on Market	Endeavors 0.0 (Jun '95); 1.0 (May '96); 1.0.7 (4/97) (alpha)	Still under development	Marvel 0.0-3.1(88-93) Marvel 3.1.(94) Oz/OzWeb(95-97)	SPADE 1 (Oct '94) Csware & Spade-1 (96)	Process Weaver(90-95); CapWeb 1.0 (Jan '97)	Visual Workflo (Sept '95) Ensemble (Nov '96) ad-hoc	3.5.2 (June '97)	3.0 (96) AutoPilot, OnTrack, 4.0 extensions due (97)	1.0 ('95) 2.0 ('96) 3.0.1 (June '97)	Notes 3.2 (Oct '94) first cross-platform 4.5 (Dec '96) current 4.6b1 (June '97)	Collabra Server 3.0 (and Calendar Server 3.0, Messaging 3.0, Enterprise 3.0) (June '97)	1.0 Exch client (Apr '96) 5.0 Server 5.0 (Apr '97)	Founded (87), HRMS (88), other markets (91-95) PeopleSoft 6 (97)	Founded ('93) 2.1 ('95) 3.0 (May '96)	1.0 ('85) 3.1 ('92) 4.0 ('94)	Shapeware ('90) 1.0 Visio ('92) Visio Corp ('95) 4.0, 4.5 Pro ('97)	
	Learning Curve	Low to High depending on type of process, integrations, and end-user views	Low to Medium depending on type of process, integrations, and end-user views	High; process encoded using type of process, requires technical proficiency	High, process development; Medium, execution	Medium to High; requires CoShell programming, but allows visual editing of processes	High; some visual and rapid app workflow development, requires high customization and technical programming	High; some visual and rapid app workflow development, requires high customization and technical programming	Medium to High; visual and rapid app workflow development; requires customization and technical programming	Medium, client and server; Medium to High for workflow app development	Medium for client; High server/maintenance; Very High app development.	Low to Medium; both client and server; High for structured workflow	Medium for client; High server. Some helpdesk & out-of-the-box tasks; High app development before deployment	Medium to High; tailorable but fixed workflow models only	Low to use; Medium to build; but fixed workflow models only	Medium small projects; High for projects over 4 people or detailed analysis	Low; easy to learn for most diagramming needs; High for workflow execution	
	Kind of support	Full-time staff support	Full-time staff support	Full-time staff support	Unknown; student-supported	Commercial product	Commercial product	Commercial product	Commercial product	Full-time support, staff	Commercial product	Commercial product	Commercial product	Commercial product	Commercial product	Commercial product	Commercial product	Commercial product
	Source of Comparison Info	Designer, Developer, Architect, extensive use, ICSP4 paper	Designer, Developer, Architect.	Designer, Developer, PI, ICSP4 paper	IEEE TSE Dec '96; ACM TOSEM Jul '96; Tech reports	http://webflow.cginm.cps.fr:4747/	demo, evaluation; http://www.filenet.com/products/	phone call; http://www.inconcert.com/prodinfo/datsheet.htm	online demo; phone call; http://www.actiontech.com/	demo; use; http://bscw.gmd.de/	http://www.lotus.com/dominio/	Evaluation Suite Spot servers; http://www.netscape.com/	http://www.microsoft.com/exchange/	http://www.peoplesoft.com/	http://www.icat.com/sections/prod/pro_ovr_3pro.htm	http://www.microsoft.com/project/press	http://www.visio.com/	
	Scalability	Medium to High; scales from individual to local area workgroup, untested enterprise.	High; scales from individual, workgroup (incl. cross organization) and enterprise w/ JDBC and database.	Medium to High; rule base becomes difficult to manage, evolve, transactions allow scaling to enterprise	Medium, process development, has abstraction, reqs. analysis tools, difficult to specify; High, end-user	Medium to High; w/ commercial database backend, limits on tool integration	High; for basic user services and management.	High; for basic user services and management.	Medium to High; for most process participants, some document and content management constraints	High; for basic user services; Medium to High for content management	High; for basic user services and management	High; for basic user services and management	High; for basic user services and management	High; excellent scalability; limited only by resources for fixed workflows	Low for general workflow; High for electronic commerce	Low; difficult to maintain consistent data and project	Low; does not scale to workflow domain	
	Entry Barrier	Low; No explicit installation to participate in process.	Low; No explicit installation to participate in process. component subsets, WWW-based views.	High for writing, Medium for participation, WWW-based but may require some install, configure, customize	High for writing, Medium for participation, some WWW agenda support w/ spade/CEI UI; requires install, configure, customize	Medium some domains, some intranet business, customer tracking; High otherwise.	High; difficult administration and installation; difficult distributed execution and cross organization	High; some packaged apps for domains; difficult distributed execution and cross organization	Medium; for some standard business domains, form-driven processes; High for others	Medium, but difficult to create workflow; Python applets allow some scripts of activities	High, collaboration/customization, diff to create workflow	Low to Medium; standard WWW protocols, interfaces, and tools; unstructured workflow only	Medium to High, server required for collaboration, difficult to create workflow	Medium for finance, manufacturing, health-care, accounting, electronic commerce;	Medium to High depending on domain	Medium to High; some project templates, consistency difficult	Low to Medium; individual application with ease-of-use & convert formats	
	Inform/Automate	Excellent; flexible execution, integration of tools.	Excellent; flexible execution, integration of tools.	Excellent automation and execution; Good tool integration	Excellent; flexible execution, integration of tools	Good; automatic invocation or available icons in context	Good; mostly automation, some inform	Good; supports both	Good; supports both	Good; mostly inform, some automation	Good; mostly inform, some automation	Good; both, but lacks automation of structured business processes	Good; mostly inform, other external	Good; focus on automation of business processes	Good; both	Inform only, analysis	Inform only	
Work/Reward Matching	Good; processes understandable by non-technical users	Excellent; with support of process agents and generation	Fair, difficult for users to change process w/o technical expertise	Poor to Fair; difficult for users to change process w/o technical expertise	Good; some promotion of individual initiative, sharing, and delegation	Poor to Fair; end user changes to process difficult; some adhoc changes	Fair; end user changes to process difficult; some adhoc & capture creation difficult	Good; shared data, own workspace management, lacks control flow	Good; shared data; Poor schema-based dataflows	Good; shared data; own workspace management, lacks control flow	Good; shared data, own workspace management, lacks control flow	Good for targeted postings; Poor for schema-based dataflows	Fair; shared workflow view, develop/deploy model	Poor; no auto collection, update of model	Good; non-technical produce/consume			
Maintenance	Low to Medium; cross-platform processes & handlers	Low; full support for process versioning and config management.	Medium to High, good versioning, rule management difficult	Medium; support for evolution and managed change for state and process	Medium for visual editing and WWW support; High for evolution/other	High; for integration, configuration, evolution, distribution, deployment	High; for integration, configuration, evolution, distribution, deployment	Medium to High, admin, configuration and deployment costs; domain depend	Medium to High, admin, configuration and deployment costs	High; admin, configuration and deployment costs	Medium; admin, configuration and deployment costs	Medium to High; good data support tools, hard-wired workflow	Medium to High; workflows have RAD tools; deliverables are apps.	High; fixed workflows but RAD tools; deliverables are apps.	High; no automatic data collection, updates by hand	High; no interconnect to workflow		
Adoptability	Easy to Medium; Integrates with existing tools and languages. Some customization and initial development of processes and objects.	Easy to Medium; Integrates with existing tools and languages. Some customization and initial development of processes and objects.	Medium to Difficult, development of new processes reqs significant effort, participation requires installation and configuration; objects can be hyperlinked	Difficult, development of new processes reqs significant effort, participation requires installation and configuration; objects managed by database	Medium for out of box processes; High to Very High depending on customizations and intended usage	High; explicit installation and deployment of workflows; database centered, some development tools; limited domains, scope, and scale	Medium to High; explicit installation and deployment of workflows; database centered, some out of box components	Medium to High; explicit installation and deployment of workflows; database centered, some out of box components	High; some basic templates; requires customization and configuration between users	Medium; installation workgroup server; immediate discussion participation; some config for advanced, needs control flow	Medium to High; pre-installed client on Windows OS, some helpdesk and out-of-box tasks, reqs config/custom	Medium to High; limited domains, templates for out-of-box, some customization and configuration	High; requires significant workflowing and collection; customization	Medium; requires agreement and external workflow support				
Granularity	Fine-grained, componentized and lightweight.	Fine-grained, componentized and lightweight.	Medium to Large-grained components	Medium to Large-grained components	Large-grained, multiple client/single server model	Large-grained, client/server model	Large-grained, client/server model	Medium-grained, client-server	Medium-grained, client-server	Large-grained, client-server model	Medium-grained, c/s model w/ push, register	Large-grained, client-server model	Large-grained, client-server model	Medium-grained components/server	Large-grained	Medium-grained		
Accessibility	multi-stakeholder, technical and non-technical users; customizable workspace and process views on WWW	multi-stakeholder, technical and non-technical users; customizable workspace and process views on WWW; domain customization	multi-stakeholder, views on WWW, work context by tool integration	Some participant roles, agenda-based interaction and work context by tool integration	Managers and participants, agenda-based interaction and work context by tool integration	Desktop work object management including prompting, query, or selection; simplifies tool access; instruction sheets provide routing information	WWW-based task list, users manage initiate tasks by adding and deleting; graphical workflow map development tool	WWW-based task list and management; users manage, initiate tasks; participate via browser; graphical workflow map/development tool	Workspace view, users manage local workspaces or subscribe to shared ones, includes graphical review of user events	Workspace view, users manage local workspaces or subscribe to shared ones, includes discussion boards and calendaring	Workspace view, users manage local workspaces or subscribe to shared ones, includes discussion boards and calendaring	Agenda based view into tasks; users manage own tasks locally using client; shared scheduling and planning	Users and definers share same visual map, support for non PS users via WWW and other; some post deployment customization	Usable by non-technical; development requires strong technical skills	Project managers only with some email notification through external tools	Editing by non-technical users; easily understandable but ambiguous		
Data Agents	Yes	Yes	Yes	No, but artifact constraints	Yes, mostly email	No, part of work object	No, but OLE automation	Yes, triggers and OLE automation, some email	Yes, Python scripts	Yes, but limited to notification	Yes, some filters and registration	No, but, external apps	Yes, plan/optimize	No, but value checks	No, but analysis	No		
Guidance	Good; components usable on WWW pages; some guidance generation	Excellent; automated guidance generation capabilities	Good; mostly reactive, execution view through tools	Good; work contexts, task list and agenda based; execution view through tools	Good; work contexts, task list and agenda based	Fair; visual maps, instruction sheets and task performer manages lists and user interaction	Fair to Good; visual maps of workflow; user involved choices and some modifications	Good; visual workflow maps; user involved choices; proactive and push technology integration	Poor; No explicit control flow; No reactive data-flow	Poor to Fair; No explicit control flow, some struct of workflow steps, reactive	Poor; No explicit control flow, No reactive dataflow, notify on post	Poor; No explicit control flow, unstructured workflow steps, reactive	Good; user feedback, steps and navigatable visual maps	Fair; enforcement only, no end-user customization, tightly controlled	Poor to Fair; interpreted by individual; some notification by email	Poor; interpreted by individual only		
Separation of Concerns	Good to Excellent; views, processes, handlers, event based integration	Excellent; views, processes, handlers, flexible event-based integration	Good to Excellent; System is componentized & can be used separate; rules lack modular hierarchy	Good to Excellent; layered architecture; communication interfaces; workspace and workflow decoupled	Poor; difficult to add views, process representation and language coupled	Poor to Fair; separates develop, deploy, and execute, process rep. and language coupled	Poor to Fair; difficult to add views, process representation and language coupled	Poor to Fair; process and workviews coupled, shared views; some extensions and integrations	Good; workspaces user definable, shared views; some dynamic config & functionality	Fair to Good; workgroups are user definable, some shared views; virtual groups	Fair to Good; workgroups are user definable, some shared views; virtual groups	Poor to Fair; some modularization and extensibility, tool integrations	Poor; workflows delivered as bundled products	Poor to Good; fixed user model; software arch flexible w/ plugins	Fair; support for multiple view into project	Poor; visualization is workflow only		
Solution Paths	Multiple subnets and paths, dynamic generation	Multiple subnets and paths, dynamic generation	Multiple paths based on bindings, dynamic chaining	Multiple subnets and paths, dynamic generation	Static intended path, data chosen subnets	mostly enforced/explicit solution paths	some enforced/explicit solution paths	Static intended path, data chosen subnets	No enforced/explicit solution path	No enforced/explicit solution path	No enforced/explicit solution path	No enforced/explicit solution path	Static intended paths w/data routing	Static, single solution path or cancel	Critical path and task dependency	None; Ambiguous		
Cross Organizational	Good; jump through organizational boundaries; leverages existing infrastructure	Excellent; jump through organizational boundaries; leverages existing infrastructure	Good to Excellent; Summit and Treaty model with rule negotiation, requires same tool across orgs; open protocols	Fair; requires same tool across orgs; limited distribution and platforms	Fair; requires same tool across organizations or shared data	Poor; requires same tool across organizations or shared data; lacks distribution & cross-platform	Fair; requires same tool across orgs & shared data; allows sub-workflows; limited distribution	Fair to Good; single fixed org model with customization; visual messages, some scope	Fair; single fixed organization model, some messaging priorities & visibility scoping	Good; completely web-based model; push, post, notify, virtual groups; lacks some enforcement	Fair; single fixed organization model, some messaging priorities	Fair; requires shared tools & install; some comparative advantage support	Fair; some support for business-to-business purchasing processes	Poor; fixed activity model, project management	Good; diagrams understandable by most stakeholders			
Rules and Constraints	Fair; programmatic only, planned integration w/ rule engine	Good; flexible server and client side management of rules including, dynamic constraints and sharing	Excellent; flexible execution and enforcement; customizable and synchronization constraints	Good; system enforced constraints on artifacts; timing and synchronization constraints or optional, mostly separate	Fair to Good; some rule management in activity editor, associate rules mandatory or optional, mostly separate	Good; validation, entry, pre-selection, sort; has some exception and bottlenecks, pre-deployment testing of maps	Poor to Fair; no explicit rule engine; some triggering of email, launch of tools, and other workflows	Fair; rules implemented as Visual Basic compatible scripting; hard-coding of exceptions	Poor w/ some support for integrating scripts in programming languages; difficult to recognize exceptions	Poor to Fair; reactive notification of content files; allows push of content; some scripting; difficult to recognize exceptions	Poor w/ some support for integrating scripts in programming languages; no fixed APIs	Poor; embedded in application logic, not configurable nor explicit	Fair; constraints on values and check on pre-conditions to purchases	Fair; standard project management rules about workloads and scheduling	Poor; None			
End User Configurable Views	Excellent; model-view-controller paradigm	Excellent; integration with GUI customization tools	Good; some web-based customization	Good; views decoupled; communication interfaces	Fair; some web-based customization	Poor; customization requires programming	Fair to Good; Task UI Designer for checklists	Fair to Good; some WWW extensions, mostly forms	Fair to Good; end-user configurable workspaces	Fair; end-user configurable workspaces	Fair; thread registration; difficult custom views	Poor to Fair; fixed shared views, minor custom	Fair; tailorable systems and integrations	Poor; interact only	Good; but limited multiple views	Good; but shared view; graph sets		
Help/Answer	Fair; automatic pub of API's on WWW.	Good; process specific help & answer; extensive hyperlinks	Fair; WWW-view and offline documentation	Poor to Fair; analysis tools	Good; context sensitive guidance	Fair; user profile dependent context presentation	Fair; can customize w/ special instructions	Fair; hyperlinks to work contexts	Fair; some searching and answer	Fair to Good; searching and hyperlinks	Good to Excellent; Helpdesk and wizards	Fair to Good; admin and reporting tools	Excellent; wizards for dev, guidance for users	Excellent; wizard and task templates	Poor for semantics; Excellent graphics			

Effort sponsored by the Defense Advanced Research Project Agency, and Rome Laboratory, Air Force Materiel Command, USAF, under agreement number F30602-97-2-2021. The U.S. Government is authorized to reproduce and distribute reprints for Governmental purposes notwithstanding any copyright notation thereon. The views and conclusions contained herein are those of the authors and should not be interpreted as necessarily representing the official policies or endorsements, either expressed or implied, of the Defense Advanced Research Project Agency, Rome Laboratory or the U.S. Government. For comments, questions, corrections, or additions, please contact Gregory Alan Bolter (gbolter@ics.uci.edu) at Information and Computer Science, University of California, Irvine, CA, 92697-3425.

	Endavors-1.0.7	Endavors-1.1+	OzWeb	SPADE	CapWeb	FileNet Visual Workflo	Xerox/Xsoft, InConcert 3.5.2	Action Technologies Metro 3.0	BSCW 3.0.1	Lotus Notes Domino (4.6b)	Netscape Collabra	Microsoft Exchange	PeopleSoft Workflow/Tools	iCAT Electronic Commerce 3.0	Microsoft Project 4.2	Visio Professional 4.5	
Object-Oriented Activities, Artifacts, and Resources	Process and Development Tools	Excellent; syntax checking, debugger, interpreter, visual editor, capture	Excellent; syntax checking, debugger, interpreter, visual editor, capture, coverage, print	Poor to Good; Needs graphical customization and visual editing	Good; full modeling and specification language, extensive analysis tools, visual editor; tool integration	Good; definition, control/tracking tools, method, context, activity, and work-flow editors	Good; composer visual process building, reuse; conductor, status & maintenance; performer execution and work objects	Good to Excellent; Organizer, UI design, workgroup management, visual process tools; work-space UI design tool	Good; graphical modeling and development; Auto-pilot deployment and RAD tool; lacks some reuse; reqs some customization	Good; Web-based development tools and languages, some customization, dynamic components	Fair to Good; open internet standards, but no explicit work-flow tools; intranet, tools for integration and extension	Poor to Fair; no explicit work-flow tools; visual programming tools can be used for some custom.	Excellent; RAD, tailor and customization, workflow, admin, reporting, integration, analysis	Poor for general workflow; Excellent for electronic commerce w/ templates and RAD, customization	Poor to Fair; task prototyping w/ tool, but no integration or execution support	Excellent diagramming; Poor workflow domain and execution	
	Semantics	Excellent; based on precise, consistent, expressive, extensible PML	Excellent; based on precise, consistent, expressive, extensible PML	Excellent; precise, expressive, extensible, declarative	Excellent; precise, expressive, extensible	Fair; fixed activity context definition, small range execution semantics	Fair; mostly fixed w/ standard attributes and access through APIs; some reuse	Fair; mostly fixed w/ standard attributes and access through APIs	Good; mostly fixed w/standard attributes and coordination primitives; email	Weak; no fixed workflow semantics	Weak; no fixed workflow semantics	Weak; no fixed workflow semantics	Weak to Fair; based on resource management and some dataflow	Good; but fixed semantic model, Fair execution, limited domain	Good; but fixed semantic model, Weak execution	Poor; None	
	Meta-Process	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No
	Ad Hoc	Yes	Yes	Yes	No	Yes	Yes, but mostly enterprise	Yes	Yes	Yes	Yes	Yes	Yes, but mostly enterprise	No	No	No	No
	Simulation	None; possible to build & integrate	Yes; simulation with data, statistical evaluation, and playback, restart from, what-if	Yes, easy to automate if data sets available, producible	Yes; simulation and testing of processes, synchronization and timing constraints	No; may be possible with automatic data and graphical playback tool.	No; but some local testing and execution before deployment	No, but some support for automation agents	No; some tracking and audit	No; some tracking and audit	No; some tracking and audit	No; some tracking and audit	No; some tracking and audit	No; but excellent analysis, capture, feedback, and reporting	No, but some walkthrough	Yes, support for what-if and change impact, no execution	No
	Roles	Poor to Fair, system programmer, process programmer, and end user.	Good; multiple roles per person, process intersection, takeover, sharing, org.	Fair to Good; but shared roles and assignment difficult during execution	Good; evolution capabilities may allow handoff and reassignment during execution	Good; sharing and delegation of activities through agenda interface	Fair; assignment and notification	Good to Excellent; allows delegation and sharing; role-based views	Good to Excellent; allows delegation and sharing; role-based views	Poor to Fair; roles assigned by login	Fair; roles are assigned by login, difficult to share/handoff	Poor to Fair; roles are assigned by login, some moderator, no handoff	Poor; support is external	Excellent; people-centric roles-based approach	Fair; fixed roles developer, seller, buyer	Poor; only resources	Poor; None
	Multi-Tiered	Yes; software arch, object, and networks	Yes; software arch, objects, and networks	No; rule base lacks modular hierarchy	Yes	No	No, client, server, database; no extensions	No, client, server, database; no extensions	No, client, server, database; no extensions; (planned)	No, but some client and server extensions	No; client-server only; no extensions	No, but client plugins and server extensions	No	Yes	No	No	No
	Security, Access Control	Fair; partial user, group, other model, basic authentication	Good; precise method and interface controls	Good, enforced through rules & web authentication	Good; enforced through PSEE login and roles	Good; basic authentication and roles, database support	Good; support for create, read, write, execute; for work perform and object	Good; basic authentication and roles, database support	Good; basic authentication and roles, database support	Excellent	Good; access control at work-spaces, docs	Good; client-based access restrictions, intranet security model	Fair; NT-based user model with login	Fair; some role-based security for display, update, delete, approval	Good; but no customization, shopping basket model	Poor; File or OS based	Poor; File or OS based
	Fault Tolerance	Good; flexible recovery, restart, escalation	Excellent; dynamic rewriting, recovery, and guidance	Excellent, exceptions are rules launched on matching	Fair to Good; evolution capabilities	Fair to Good; limited dynamism, some timeout, workaround; user dep	Fair; validation rules; some timeout & constraints, no exception handling	Fair; some delegate and modify, no explicit exception handling	Good; rollback, locking, concurrency; lacks robust exceptions and dynamism	Good; versioning & support; Poor exception handling	Fair; backup, save, recover model; Poor exception handling	Poor; no explicit control flow & exception handling	Poor; no explicit control flow & exception handling	Poor; no explicit control flow & exception handling	Excellent; only w/in supported processes	Poor; notification only, no execution	Poor; N/A for workflow domain
	Configuration Management	Poor; versioning work in progress	Good; includes process versioning	Excellent; rollback and versioning	Fair; database dependent	Fair; database dependent	Fair; database dependent	Fair; database dependent	Fair; database dependent	Fair; some support for recover and audit	Fair; some support for recover and audit	Fair; some support for recover and audit	Fair; some support for recovery and audit	Fair; database dependent	Fair;	Poor; no versioning, explicit save	Poor; no versioning, explicit save
Transactions	Poor; transactions work in progress	Good; includes process rollback, versioning, flexible completion	Excellent; flexible	Good; database dependent	Good; database dependent	Good; database dependent	Good; database dependent	Good; database dependent	Good	Fair	Poor to Fair	Poor to Fair	Excellent; middleware dependent (external)	Good; purchasing only	Poor; some session undo, editing only	Poor; some session undo, editing only	
Automation	Excellent	Excellent	Excellent	Excellent	Good	Fair, lacks scripting, agents	Fair, lacks scripting	Fair to Good	Fair; flexible scripting	Poor; some scripting	Good; agents & CGI	Fair; w/ OLE/ActiveX	Fair to Good	Good; but user driven	Poor; None	Poor; None	
Concurrency	High; lightweight, multi-threaded	High, lightweight, multi-threaded	Medium, some process limits, heavyweight	Medium; supported at client/server level; timing support	Medium; supported at client/server level	Medium; heavyweight client/server	Medium; heavyweight client/server	Medium; middle-weight client/server	Medium; middleweight client/server	Medium; heavyweight client/server	Medium; middle-weight client/server	Medium; heavyweight client/server	Medium; heavyweight client/server	Medium; heavyweight client/server	Low; None	Low; None	
Abstraction/ Escalation	Excellent; including hyperlinks and mobile processes	Excellent; including hyperlinks and mobile processes	Fair; by separating rule spaces across sites	Fair to Good; supports sub-processes, evolution	Fair; method editor provides some prioritization and notification	Fair; flexible control flow primitives; limited encapsulation	Fair to Good; supports sub-workflows, delegation, re-routing	Fair to Good; supports sub-workflows, delegation, re-routing	Fair to Good; integrated with WWW and flexible workspaces	Poor to Fair; some WWW support of hyperlinks	Fair to Good; integrated with WWW, hyperlinks, but limited task ordering	Poor to Fair; sub-tasks, integration with project management	Fair; distribution, but fixed processes limited exceptions	Poor; fixed tasks, no escalation	Fair to Good; some abstraction of tasks/sub-tasks, priorities	Good visualization; Poor workflow	
Multi-Directional	Both; serial and parallel	Both; serial and parallel	Both; serial and some limited parallel	Both; serial and parallel	Both; serial and some limited parallel	mostly serial	mostly serial	mostly serial	mostly serial	mostly serial	mostly serial	mostly serial	Both	mostly serial	serial only	N/A	
Multi-synchronous	Both; sync & async	Both; sync & async	Both; sync & async	Both; sync & async	Both; sync & async	mostly sync	mostly async	Both; sync & async	Both; sync & async	mostly async	Both; sync & async	mostly async	Both	synchronous	Some async (email)	N/A	
Multiple Languages	Yes; Java, Python, Tcl, Perl, Ada95 through libwww	Yes; Java, Python, Tcl, Perl, Ada95, w/ embedded interpreter	No; OzScript only	No; Slang constructs	No; CoShell only	No, C/C++ only APIs	No, C/C++ only APIs	No; Visual Basic for scripts, C/C++ DLL and OLE access	No; Python only	Yes, app development C++/C, some Java applet support	No, although some server plugins may be possible, command line	Yes, Visual Basic, C, C++, J++, scripts	Unknown, mentions Java	No; Carbo ICL with some plug-ins	No, but some customization w/ Visual Basic	No; workflow independent of diagram	
Cross Platform	Excellent; processes, tools, interpreter	Excellent; processes, tools, interpreter	Fair to Good; rules and limited system	Poor to Fair; limited systems; agenda WWW view	Fair to Good; agenda and WWW views	Poor; single client, multiple server; don't interoperate	Poor to Good; multiple but don't interoperate	Poor for workflows and limited server; Fair client	Good; both client and server, scripts	Good; office tools & scripts limited targets	Good; both client and server	Fair; data only, tools and scripts target only	Good; but ported systems only	Good; but ported systems only	Poor; data only on supported platforms	No; workflow independent of diagram	
Metrics and Measurement	Fair to Good; mostly static; utilizes discovery tools	Good; static and dynamic; extensively automated tracking & monitoring	Fair; mostly static; trace history	Excellent for analysis and model checking; Fair for visual status and context	Good; automated collection, tracking & monitoring	Good; tracking and reporting; volume, delay, completion, throughput	Fair to Good; automatic tracking and reporting; external audit tools	Fair; status, tracking and updates; some reporting	Good; event tracking and display; audits, trails, versioning, logs	Good to Good; audits, trails, access, logs	Good; audits, trails, access, scheduling	Good; audits, trails, access, scheduling	Excellent; reporting and analysis, data collection	Good; SQL/ODBC interface and logs	Excellent analysis; Poor collection, consistency, maintenance.	Poor; no support	
Process Data and Programs	Excellent, separate	Excellent, separate	Excellent, separate	Excellent, separate	Fair; weak separate; mostly embedding	Good; process and data can be dynamically changed independently	Fair; event action triggering but weak separation	Fair; event action triggering but weak separation	Poor; no process definition, data only	Poor; no process definition, data only	Poor; no process definition, data only	Poor; no process definition, data only	Fair; no control flow, event-based integration.	Fair to Good; command language and templates	Fair; task dependency; no execution	Poor; no process program	
Communication and Collaboration Tools	Fair, but; planned email, WebDAV, BSCW, Collabra, others; Messaging and other protocols.	Excellent; integration with calendar, scheduling, board, and email, groupware and others	Fair; agenda based, possible support for others with web views	Good to Excellent; ImageDesk CSCW toolkit for implementing communication and collaboration tools	Fair; agenda based, possible support for others with web views	Poor to Fair; work objects generally single person primitive or shared queue with status management	Good; task and workgroup management; limited support	Fair to Good; some ad hoc initiation and routing; shared queues and agendas; alternate views	Excellent; shared folders, news, threading, notification, visual event management	Excellent; shared folders, news, email, threading, notification, workspaces	Excellent; shared folders, news, email, threading, organization	Good to Excellent; shared folders, news, email, threading	Fair to Good; some support integrated through application sever, across sites	Poor; fixed collaboration channels between buyer and seller only	Fair; some email	Poor; some support for WWW links	
Events	Good; registration, broadcast, HTTP, definable	Excellent; registration, multicast, push/pull, over HTTP, RMI, CORBA	Good; HTTP support across internet and RPC.	Events are transitions fired in model; some BMS integration	Fair; dispatching of work contexts to agendas, agent based filtering email	Fair; some explicit event definitions, but no external event registration	Fair to Good; event triggers; difficult registration on APIs	Fair; business events and some triggers and notification; some broadcast	Good; tracking, HTTP-based, but pull model of broadcast	Good; email based messaging, some change tracking	Fair to Good; message based events, post, send, reply; agent registration	Fair to Good; messages, post, send, reply; lacks program registration	Good; middleware for events, request/reply & publish/subscribe	Fair; data submittal only from send	Poor; managed through tool only; complete/update	Poor; None	
Flexibility	Excellent	Excellent	Good to Excellent	Good to Excellent	Good	Fair to Good	Fair	Fair to Good	Good	Good	Good	Good	Fair	Poor to Good	Fair	Fair	
Programmability	Excellent	Excellent	Fair to Good	Fair	Fair to Good	Good; APIs & standard. tools	Fair; standard APIs	Fair to Good; lacks APIs	Good to Excellent	Fair to Good	Good	Fair; low level only	Good; standard APIs	Good	Fair	Poor	
Extensibility	Excellent; process model, execution, views, integration, and data	Excellent; process model, execution, views, integration, data, and policies	Good to Excellent; toolkits and interfaces; views and integration	Good to Excellent; toolkits and interfaces; views and integration	Fair to Good; activity contexts extendible, but fixed execution model	Fair; programmable on client side only; work objects extendible, but fixed infrastructure	Good workflow and work-spaces; Fair for infrastructure and execution engine	Good control flow; Good for infrastructure and desktop components	Poor control flow; Good for infrastructure and desktop components	Poor control flow; Fair infrastructure; Good desktop components	Poor control flow; Good; infrastructure for various workflow technologies; needs add-on	Poor control flow; Good; infrastructure for various workflow technologies; needs add-on	Fair; tools programmatically w/ application sever, fixed execution model	Good; limited, but extendible command language and server side plug-ins	Poor to Fair; extensible views only, fixed project model	Poor; but may be possible to extend based on intermediate data	
support/dictate	Both	Both	Both	Both	mostly dictate	mostly dictate	mostly dictate	mostly dictate	support only	mostly support	support only	support only	mostly dictate	mostly dictate	Some dictate (email)	Neither	
Customization	Fair to Excellent; depending on domain, Open APIs	Good to Excellent	Fair; high startup cost, system components reusable, rules difficult	Good; high startup cost; interfaces for extensions; fixed execution model	Fair; mostly client, fixed, some end-user custom., fixed exec	Poor to Fair; client side only, difficult execution, no end-user customization	Fair to Good; interfaces and workspaces but fixed workflow model	Fair to Good; interfaces and workspaces but fixed workflow model	Good to Excellent	Fair policy; Good intranet tools support.	Fair policy; Good intranet tools support.	Fair; difficult policy changes, some programmatic	Poor to Good; dependent on application and scope	Good; language is extendible; RAD tools, custom views/templates	Fair; some Visual Basic, menus, toolbars	Good graphics; Poor workflow	
Searching/Sorting	None; planned	Fair; external engine	Good; database query and WWW	Fair; database query	Fair; database query	Fair; database query	Fair; database query	Fair; database query	Good	Good	Excellent	Excellent	Good; DB query	Good; SQL/ODBC	Poor; text search	Poor	
Process Fragments	Yes; cut, copy, paste, email, HTML embedded	Yes, cut, copy, paste, email, HTML embedded	Yes, but rule dependencies difficult to determine	Yes; editing and reuse	No, but some modular hierarchy	No, but some modular hierarchy, work object reuse	No, but some modular hierarchy	No, but some modular hierarchy; rollback	No; no process definition	No; no process definition	No; no process definition	No; no process definition	No; strongly tied to context, data driven	No; single process, some reuse	Yes; some abstraction, consolidation	No; visualization only	
Intranet/Internet/ Extranet	Intranet/Internet; some security requirements, works through firewalls and HTTP based	All ready, tunneling across sites w/ firewalls & HTTP	Intranet/Internet; requires some security and backend limits platforms; clients through firewalls & HTTP	Some Intranet with agenda	Intranet, some remote site access w/ remote agenda and HTTP access	None; TCP and IPX access only on LAN	None; TCP and NFS only	All; client model with fixed server; some additional security needs; but lacks mobile processes, evolution	All; good user model, flexibility, and extensibility; some additional security needs	Intranet, some extranet with clients, secure/scale/config problems w/internet	All; good user model, flexibility, and extensibility; tightly integrated with WWW protocols	Some Intranet, lacks tight integration with WWW & protocols	Some Intranet client support, but based on non-web distributed protocols	Internet only; possible extranet with business-to-business connections	None	None	
Processes	Excellent; people, processes, tools, data	Excellent; people, processes, tools, data	Good; people, processes, some tools not portable	Excellent; people, processes, tools, data	Good for people & data, Fair tools	Good for control flow, artifacts, documents, routing	Fair; Roles, ad-hoc routing, configurable desktop, integration	Good for roles, people, data, and tools; lacks some document management	Poor; data-driven, pull model, no formal process model	Poor to Fair; data-driven only, no formal process model	Poor; but some task management, priorities, project management, dates, reminders	Poor; lacks formal process definition model	Good people & data; some tools and execution	Fair; fixed processes, user submissions with automated steps	Fair; lacks reuse, loops, conditional execution, accuracy	Poor; visualization only	
Local/Global	Yes, both	Yes, both	Yes, both	Yes, both	mostly local	mostly enterprise	mostly enterprise	Yes, both	mostly workgroups	mostly enterprise	Yes, both	mostly enterprise	mostly enterprise	mostly local	mostly local	Local only	
Routing and Naming	Good to Excellent; URL/ URI/ URN, leverages WWW protocols and formats	Good to Excellent; URL/ URI/ URN, leverages WWW protocols and formats	Good; remote routing, explicit named URL's for objects	Fair; support mostly for managed objects, named database objects	Fair; support mostly for managed objects, named database objects	Fair; support mostly for managed objects, named database objects, documents	Fair; support mostly for managed objects, named database objects, documents	Fair to Good; uses URL access to shared work context and hyperlinks from email; remote routing	Poor routing; Good, Web-based naming and locations; annotations, editing, versioning	Fair; email notification with priority tags; basic scripting	Fair routing with forwarding and registration/notification; Excellent naming	Fair to Good; supports multiple network protocols and platforms. Some programmatic routing	Good; dynamic data dependent routing, enterprise event routing w/ middleware installation	Poor to Fair; fixed routing and data channels, clients on WWW	Poor; some email	Poor; None	
Builtin Networking	Yes; HTTP	Yes; HTTP & others	Yes, HTTP, RPC	Yes, mostly RPC	Yes, some HTTP, RPC	Yes, some RPC, IPX	Yes, some RPC, NFS	Yes, HTTP, others	Yes; HTTP	Yes; TCP, IPX	Yes; HTTP, others	Yes	Yes, DCE, RPC	Yes	No	No	
Low Bandwidth/ Disconnected	Yes; suited for PDA, thin clients, modem & wireless	Yes; suited for PDA, thin clients, modem & wireless	Yes; Web-client support, and laptops	No; but some Web-client support	No; but some Web-client support	No; fixed LAN access only; no thin clients	No; fixed LAN access only; no thin clients	No; but Web-client support	Yes, through browser but no thin clients	Yes, modem support, but no thin clients	Yes, through browser, PDAs, offline	Yes; some data transfer over modem & PDAs	Yes, fixed non-conventional, other	Yes; browser-based clients	No	No	
Contingencies and Handoff	Good to Excellent; resume, start, start from, handoff, assignment and delivery	Good to Excellent; resume, start, start from, handoff, assignment and delivery	Excellent; flexible rule-chaining, and rollback	Excellent for limited contingencies; Fair otherwise	Poor; limited dynamics and; no flexible exception handling	Fair; some dynamic handoff; no flexible exception handling	Fair; some dynamism but no flexible exception handling	Fair to Good; lacks robust exceptions, but includes handoff and delegation	Poor to Fair; lacks exception handling, includes recovery	Poor to Fair; lacks exception handling, includes recovery	Poor to Fair; lacks exception handling, includes recovery	Poor to Fair; lacks exception handling, includes recovery	Fair to Good; transactions and limited flexible exceptions	Poor; abort/failure/retry only	Poor; no support for exception handling	Poor	
Evolution and Optimization	Good to Excellent; needs some config management & better access control issues	Excellent; evolution and feedback support including reflexive change	Excellent; late-binding, manipulate executing process fragments; type definitions; active state	Excellent; mechanisms for changing process and state	Fair; lacks compositional reuse and dynamic change	Fair; dynamism and status; no process feedback	Poor to Fair for process, reuse; Poor for system infrastructure	Poor; fixed workflow model; difficult infrastructure changes	Fair; drag-and-drop thread manipulation publish/store/retrieve	Poor to Fair; some views, but program dependent	Poor; program dependent	Poor; program dependent	Poor; fixed execution, deployment/upgrade model	Poor to Fair; RAD tools, but difficult incremental evolution	Poor; data consistency expensive	Poor; no link/consistency diagram and execution	
Dynamic Behaviors	Excellent; point of execution, multiple network selection, dynamic type, dynamic change of handlers	Excellent; point of execution, multiple network selection, dynamic type, dynamic change of handlers	Good to Excellent; extend PML & execution	Good; mechanisms for changing process and state	Fair; some support for changing CoShell behaviors and routing.	Fair to Good; dynamic data, validation, process; no infrastructure evolution	Poor to Fair; some dynamic workflow changes, but no dynamic behaviors	Poor; no dynamic change of executing process; no reflexive process changes	Poor to Fair; views dynamically generated from data	Poor; limited to data organization	Poor; limited to data organization	Poor to Fair; some dynamic schema definition for data.	Fair; support for dynamic data routing and workflow change w/o application change	Poor; fixed process (may ensure security)	Poor; minimal execution model	Poor; behaviors completely external to system; no support.	
Reflexive	Yes; arch, processes and views	Yes; arch, processes and views	No; some rule creation and exec engine change	Yes, process and data	No	No	No	No	No	No	No	No	No	No	No	No	
Partial Execution	Yes; incremental	Yes; incremental & dynamic generated	Yes	Yes	No; fixed execution, some modular processes.	No; fixed execution, some modularity; work objects	No; fixed execution, some modular processes.	Yes; with rollback/reset	No; lacks execution model and control	No; lacks execution model and control	No; lacks execution model and control	No; lacks execution model and control	No; fixed execution, transaction rollback	No; lacks execution model, infrastructure.	No; lacks execution model, infrastructure.	No; lacks execution model, infrastructure.	

Object-Oriented Activities, Artifacts, and Resources

Integration

Customization and Reuse

Distribution

Dynamic Change

Effort sponsored by the Defense Advanced Research Projects Agency, and Rome Laboratory, Air Force Materiel Command, USAF, under agreement number F30602-97-2-0021. The U.S. Government is authorized to reproduce and distribute reprints for Governmental purposes notwithstanding any copyright notation thereon. This document is the property of the Defense Advanced Research Projects Agency, Rome Laboratory or the U.S. Government. For comments, questions, corrections or additions, please contact Gregory Alan Bolser (gbolser@ics.utcd.edu) at Information and Computer Science, University of California, Irvine, Irvine, CA, 92697-3425.