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TRAMP Problem Statement

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Inmedius, Inc. and

Carnegie Mellon University

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Presentation Outline

- **Organizational Relationships**
- Concept of Operations
- Problem Statement: Tramp Scenario
- Spot wearable system components
- Spot processor unit details
- Software Components



Organizational Relationships

- Inmedius, Inc. (Inmedius)
 - Carnegie Mellon spin-off company in Pittsburgh, PA, USA
- Inmedius Europa GmbH (“In Formation” 21/9/01)
 - Wholly owned subsidiary of Inmedius in Munich, Germany
 - European marketing and product engineering/support
- Carnegie Mellon and Technical University of Munich
 - CMU Institute for Software Research International (ISRI)
 - TUM Chair for Applied Software Engineering
 - R&D collaboration with Inmedius and Inmedius Europa
 - Source of exceptional Inmedius/Inmedius Europa employees



Organizational Relationships - 2

- Wearable Group at Carnegie Mellon has pioneered wearable computing since 1990
 - Professors Dan Siewiorek and Dick Martin co-direct group
 - Dr. Jane Siegel leads usability studies and design feedback
 - Group has developed and tested with end users over 24 wearable/mobile systems
- Spot prototype system is being developed by Inmedius with hardware engineering and design support from Carnegie Mellon
 - Commercialization efforts underway



Organizational Relationships - 3

- Inmedius is doing a pilot project for an “imaginary” car company
 - To demonstrate a scenario for mobile maintenance of a defective car subsystem (Headlight Turn Signal System)
 - The TRAMP team is the “sub-contractor” to Inmedius as a system solutions provider
- Inmedius is doing an advanced R&D project for an “imaginary” car company
 - To demonstrate a visionary scenario for mobile maintenance using UMTS connectivity and Synthetic Expert User Interface (Garage of the Future)
 - Inmedius Europa is the “sub-contractor” to Inmedius as a system solutions provider

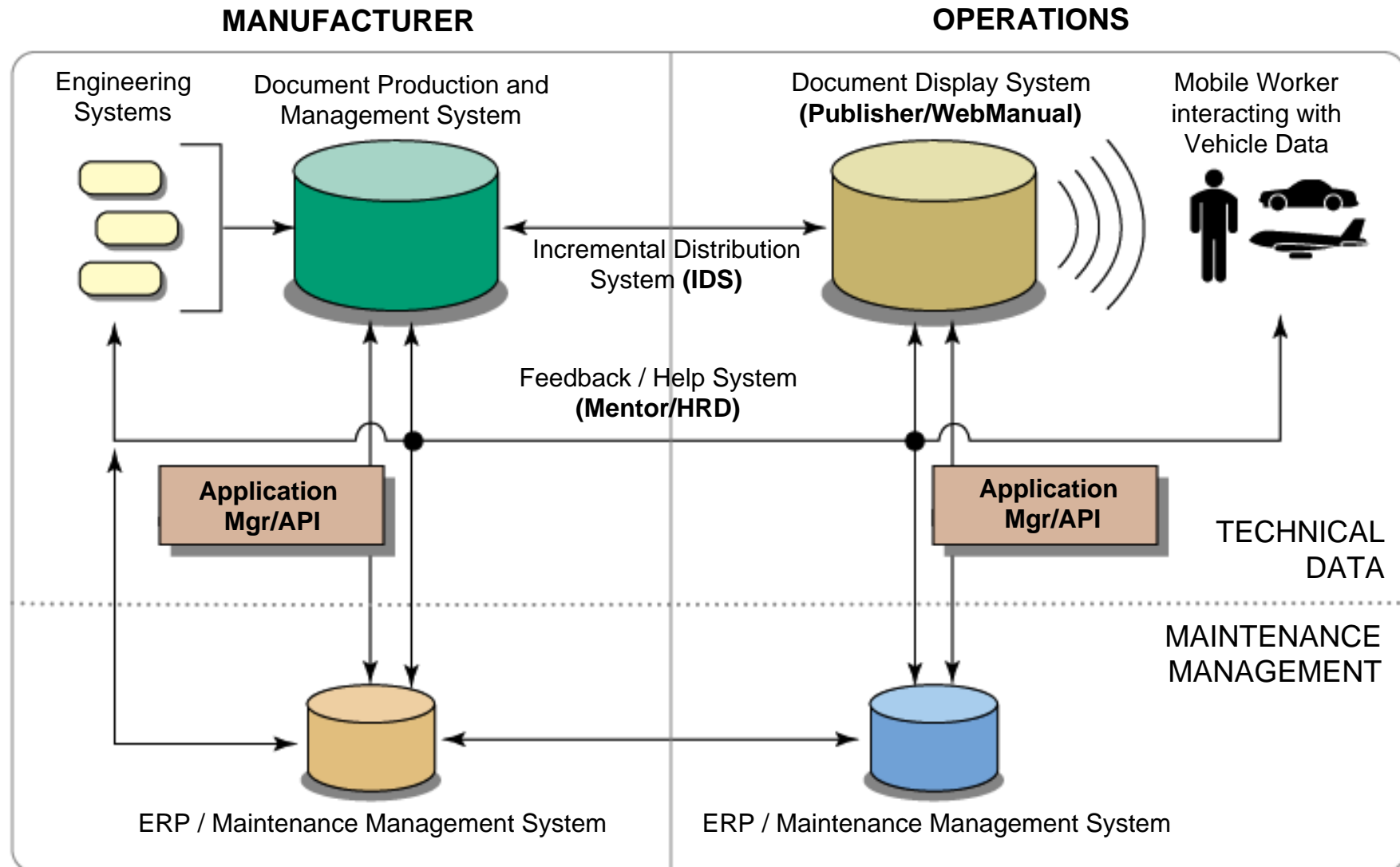


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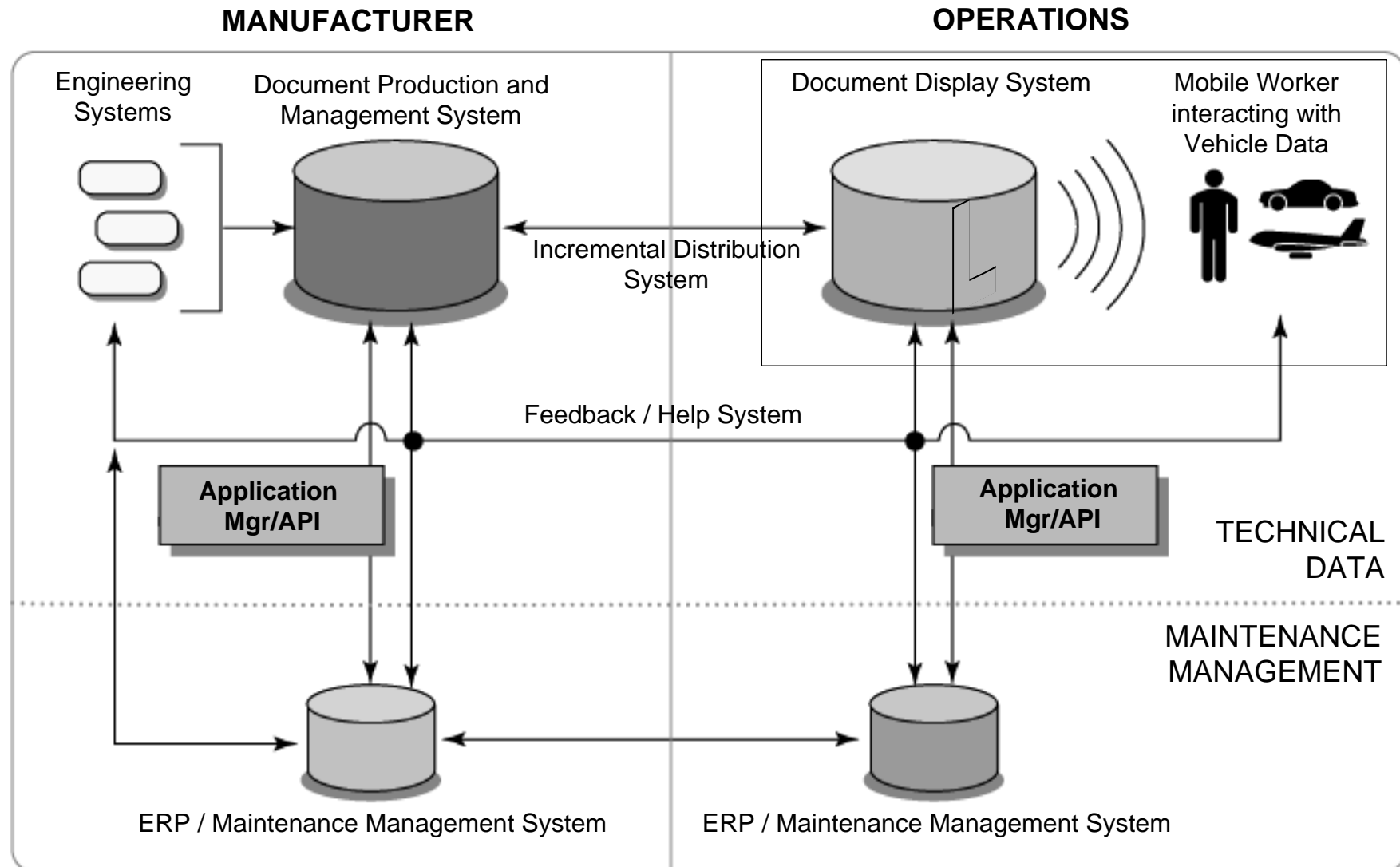


Concept of Operations





Concept of Operations

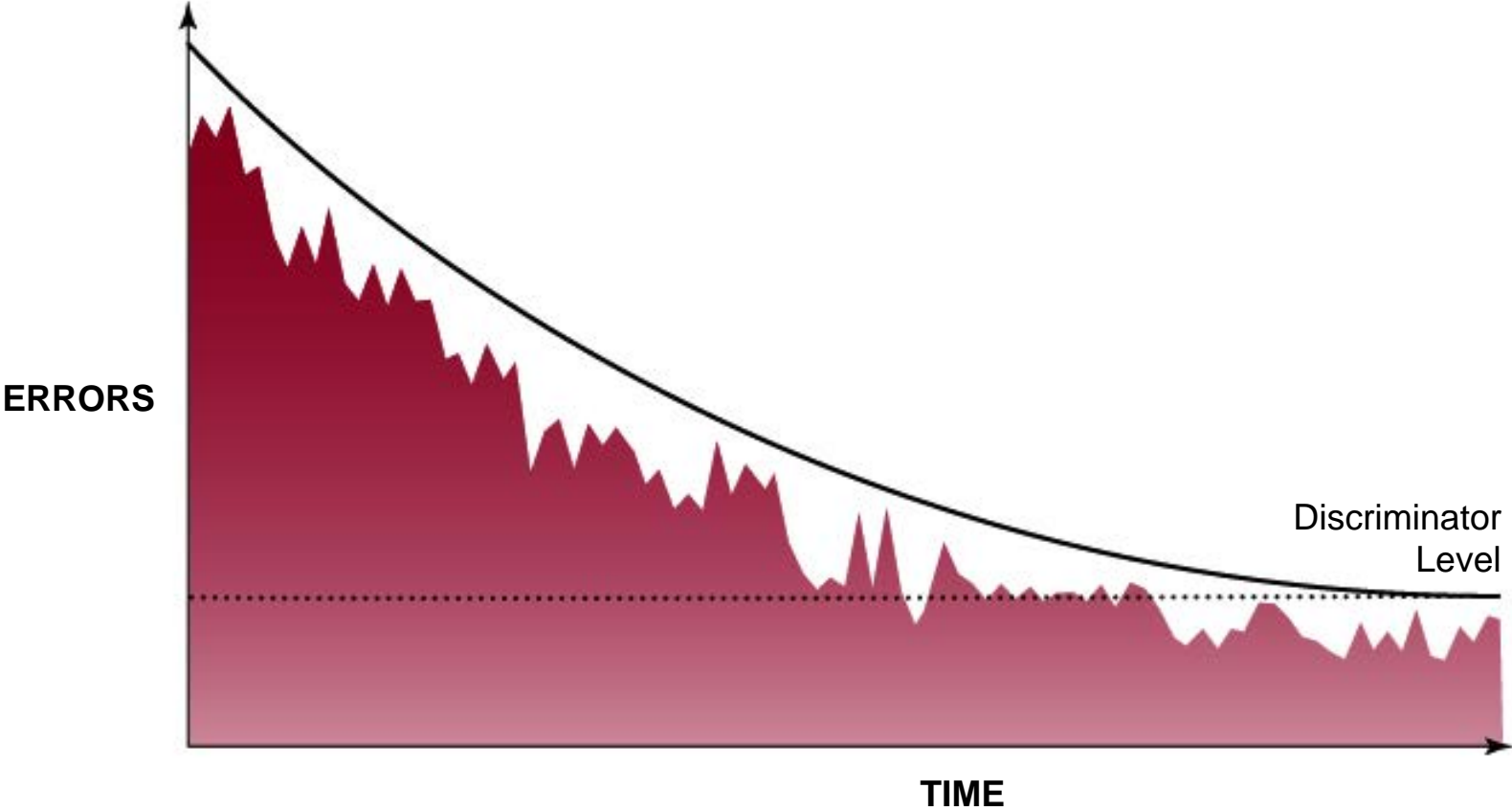




Personnel Performance Enhancement Root Causes

- When the following conditions are met, then equipment can be properly operated and maintained
 - Operating and maintenance technical data are correct
 - Component lifetimes follow the manufacturer's failure analysis and maintenance plan
 - People are properly trained
- When any of these aren't met, then people guess and expensive errors can occur
 - Need to provide problem feedback and quick corrective action to the above three conditions to keep problems small

Results of Feedback/Quick Corrective Action





Why Interactive Electronic Tech Manuals (IETMs)

- “Mass customization” requires dynamically configured maintenance information for each vehicle at time of work
- Mobile workers require very simple User Interfaces with automatic integration of information from various, independent sources
 - Maintenance procedures
 - Diagnostics
 - Expert help
 - Configuration of vehicle
 - Repair parts



Five Classes of IETMs

- **Class 1:** View full page image with index to pages
- **Class 2:** Scrolling text with hot spot links to other data
- **Class 3:** View tagged documents through smaller logical blocks of text and graphics with less scrolling
- **Class 4:** Data authored to data base for dynamic, interactive output and display
- **Class 5:** Expert system added to class 4 to assist in output and display of information



DoD JIA Class 5 Web-browser User Interface

The screenshot shows a Microsoft Internet Explorer browser window titled "WebManual - Microsoft Internet Explorer". The address bar contains the URL http://aimss_server/aimss/enter.asp?db=venture. The browser's menu bar includes File, Edit, View, Favorites, Tools, and Help. The toolbar contains icons for Back, Forward, Stop, Refresh, Home, Search, Favorites, History, Mail, and Print. The main content area displays a manual page titled "BIT PROCEDURE FOR CONVERTER : VERIFY TEST RESULT". The page has a navigation bar with tabs for "Manual", "Locate", "Program", and "Help". The "Manual" tab is selected. The page content is divided into two columns. The left column contains a list of instructions: 1) If additional operator actions are required, perform them as directed by this manual. 2) Verify BUILT IN TEST - LLSI CONVERTER - PASS and FAIL indicators stop blinking to indicate test completion. 3) For a pass/fail test, observe test result: a) Pass: BUILT IN TEST - LLSI CONVERTER - PASS indicator is lit, BUILT IN TEST - LLSI CONVERTER - FAIL indicator is not lit. b) Fail: BUILT IN TEST - LLSI CONVERTER - PASS indicator is not lit, BUILT IN TEST - LLSI CONVERTER - FAIL indicator is lit. The right column contains a photograph of a control panel labeled "BUILT IN TEST". The panel features a "TEST SELECT" section with "MSD" and "LSU" indicators, both set to "0". To the right are two indicator sections: "LLSI CONVERTER" with "PASS" (green) and "FAIL" (red) lights, and "FILESERVER" with "PASS" (green) and "FAIL" (red) lights. Below these is an "ENTER" button. The browser's status bar at the bottom shows "Local intranet".



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Selection of IETM “hot links” with Wheel/Pointer





Next-generation IETM User Interface

The screenshot displays a software interface for an INS Ground Initiated BIT Test. The interface has a light green header with a row of eight small square icons. Below the header, the main content area is divided into two sections. On the left is a list of instructions, and on the right is a large blue note box.

INS Ground Initiated BIT Test
Preliminary Instructions

- Do nose wheelwell digital display indicator built-in test/reset procedure.
- Apply electrical power.
- On GND PWR control panel assembly, set and hold 1 and 2 switches to B ON for 3 seconds. Switches latch and remain on.
- On left digital display indicator (LDDI), set power switch to DAY or NIGHT as applicable. Allow 2 minute warmup and adjust BRT and CONT for best display. LDDI displays MENU pushbutton switch option.

Note

Component locations are shown in WP004 00.

If a malfunction occurs during this test, make sure circuit breakers shown in WP004 00 are closed.



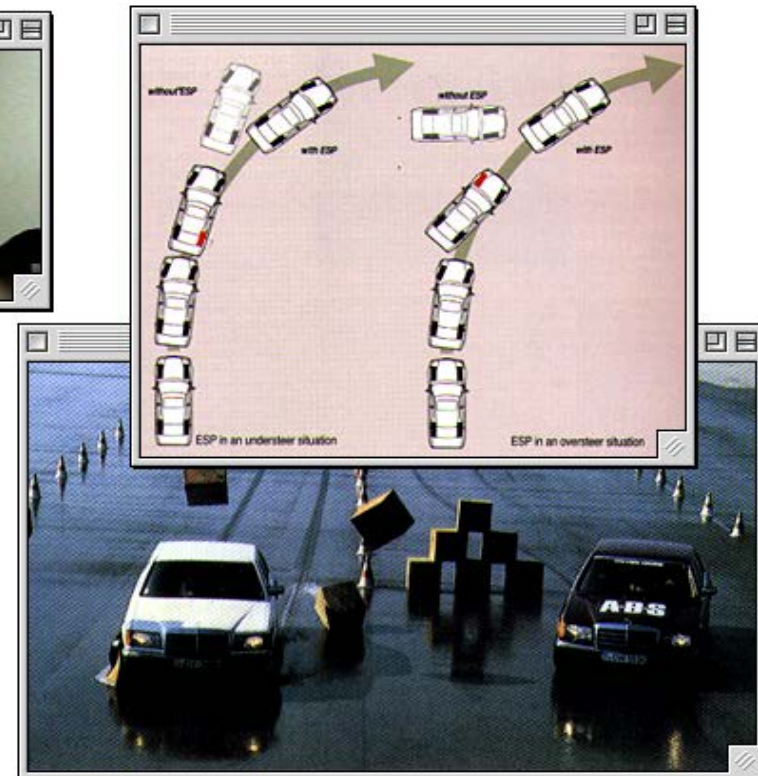
Advanced Interface: Synthetic Expert

- Captures and conveys a sense of human-to-human interaction (anthropomorphic interface)
- Simulates conversation and provides Rule-based responses
- Enables natural language dialog



Scenario:

- Expert technician answers questions
- Diagram in separate window
- Video simulation in third window
- Use of Synthetic Interview technology





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- John's head light turn signal does not work anymore, so he decides to go to a nearby garage.
- When he arrives there, Toni, the customer representative at the reception enters the problem into his wearable computer, Spot
 - Toni wears a head mounted display and uses speech recognition and Inmedius' Wheel/Pointer to interact with his wearable computer.
 - Toni is advised by his wearable to reproduce the failure. Toni lets John sit in his car and activate the turn signal. It does not work.
- Spot displays the following advice:
 - “Let the customer drive the car to parking lot 235 where the customer should meet a mechanic.”
- The customer drives to lot 235.
- Meanwhile Brandon, a mechanic who is inside the garage, gets a notification (via wireless ethernet):
 - “Show up at lot 235”.



- Brandon also receives repair instructions as an IETM (interactive electronic technical manual).
 - Brandon puts necessary spare parts into his toolbox and goes to the parking-lot guided by navigation information displayed in his HMD.
- At the parking lot John is already waiting.
 - Brandon first checks the fuse-box following the steps automatically displayed inside his HMD.
 - When he opens the fuse box - which is automatically detected by the optical tracker in his wearable system, the next instruction is displayed: “Check the fuse number 3123”.
 - The fuse is OK, so a new set of instructions starts to check the signal
 - Brandon then checks the lamp of the turn signal.
 - He finds out that the lamp is blown, so he replaces it and checks whether the new one works (it does).
- Brandon enters the payment information of John into his wearable (speech) and transmits the information via UMTS.



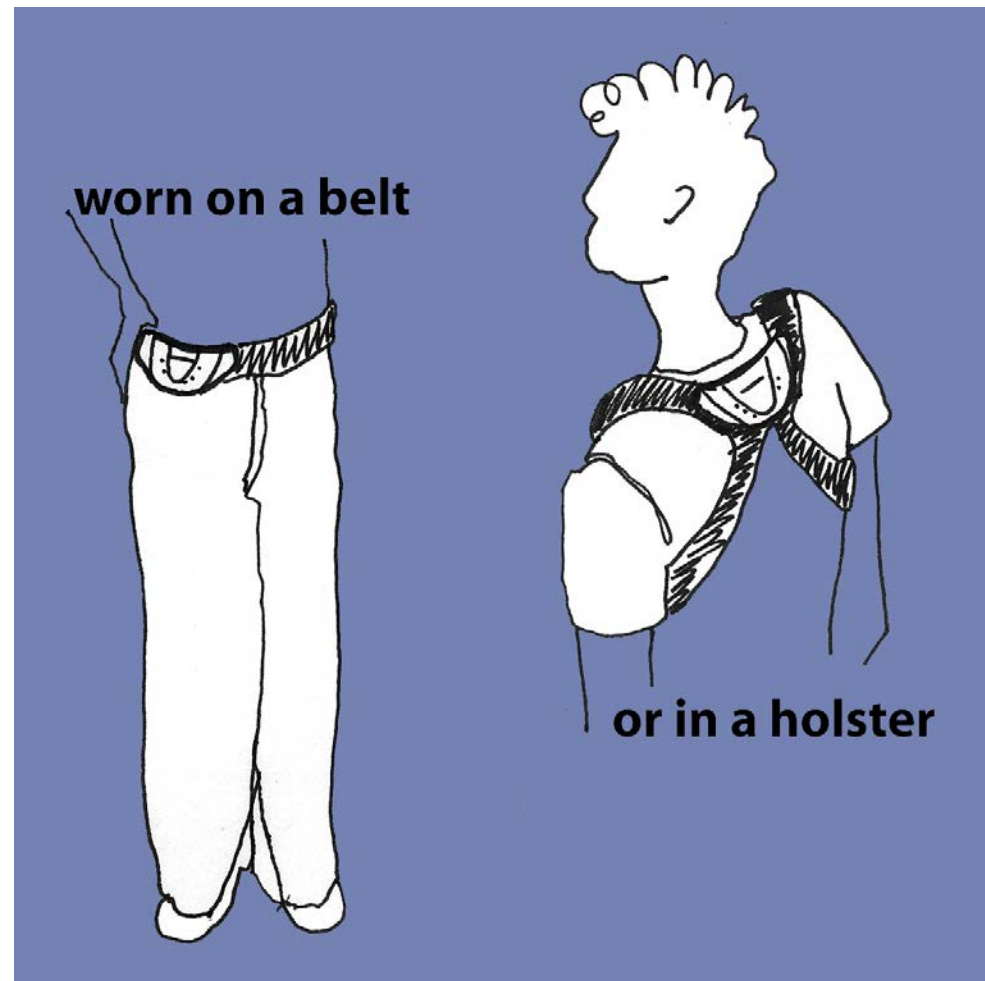
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Spot - On the Body

- First unit small enough/configured for wearing at top of shoulders
- Spot Core is unobtrusive
- I/O wires are carefully routed
- Custom Configurations





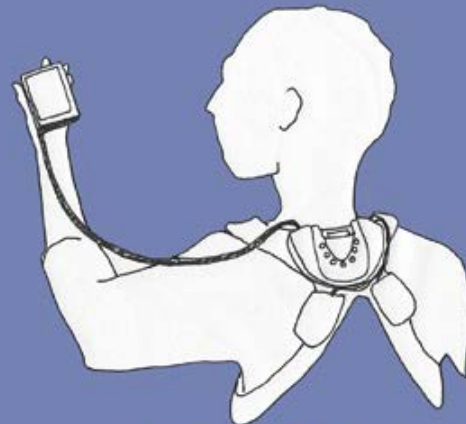
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Configured for Any Task or Interaction Model

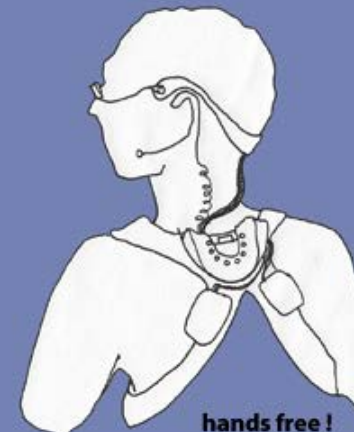
Spot Configurations :



pointer or dial on front of harness



handheld GPS or Touchscreen LCD



hands free !



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Spot Wearable Computer With IBM Display

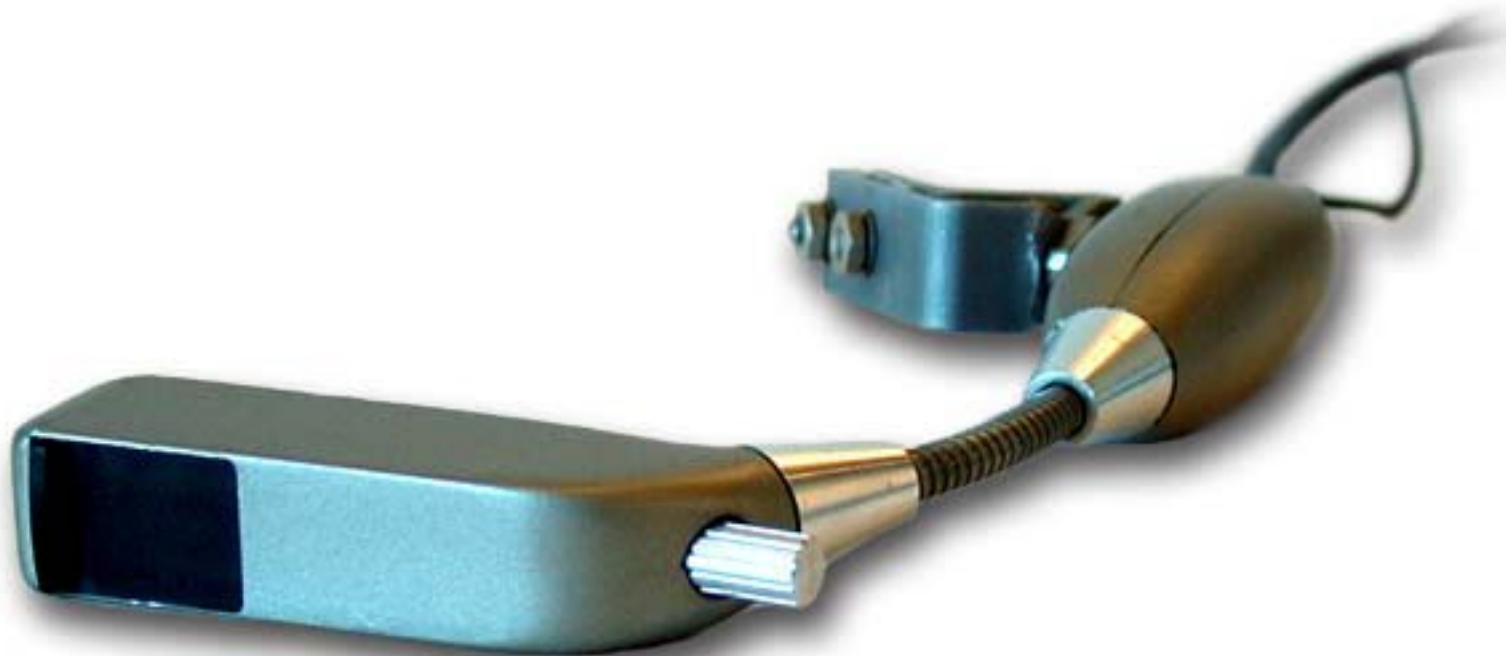


- Spot (the device on the right) weighs about 9.5 oz and fits in the palm of a hand or in a pocket
- Electronic box under the display goes away when ASIC chip is added in display unit to replace digital-analog function of box



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IBM Head Mounted Display (HMD) Details



- Configuration of HMD with ASIC chip in display unit and mounting bracket for Navy “cranial helmet”



Wheel/Pointer Details

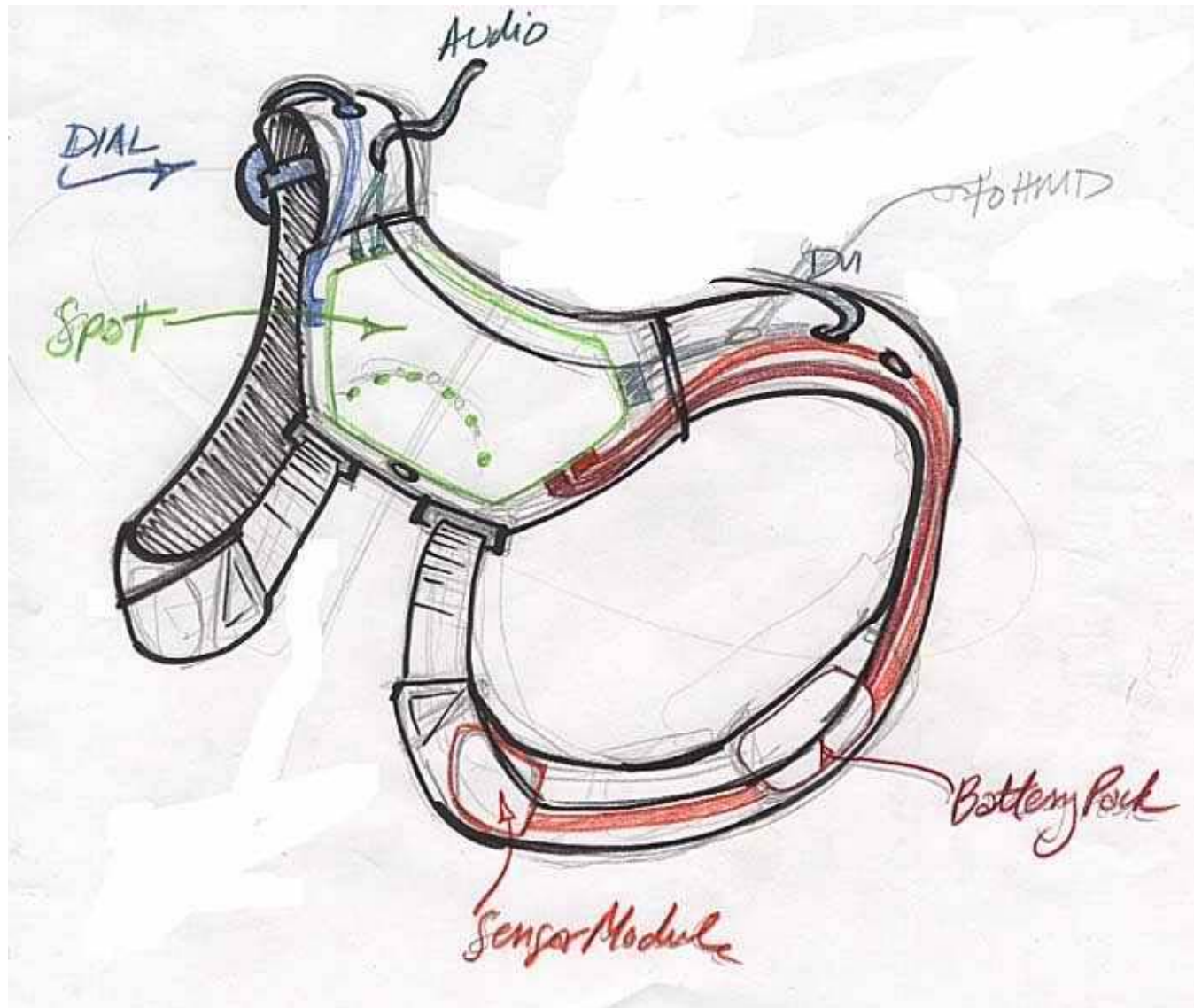


- Rotate to select desired “hot link”, then press to select
- Single mouse “button” for additional UI functions
- Mouse “pointer” in middle for use in collaboration



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Spot Context Sensitive System Configuration





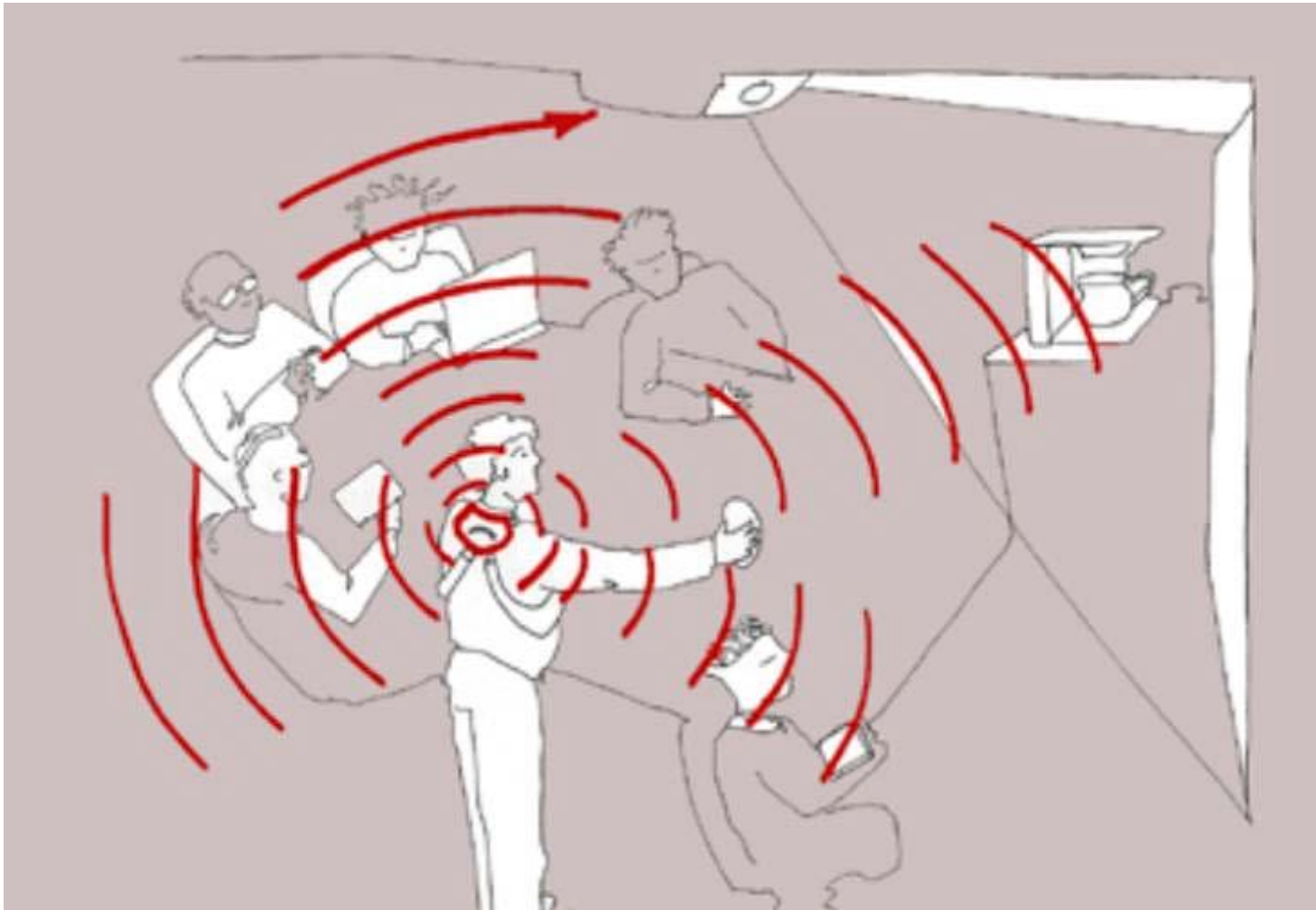
Spot Context Sensitive Application Scenarios

- Location-aware
 - Seamless switching between UMTS and 802.11b data communications
 - Applications tailored by location
- Interaction with objects in vicinity via Bluetooth
 - Maintenance of equipment
 - Operation of consumer objects



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Spot Operation of Consumer Objects





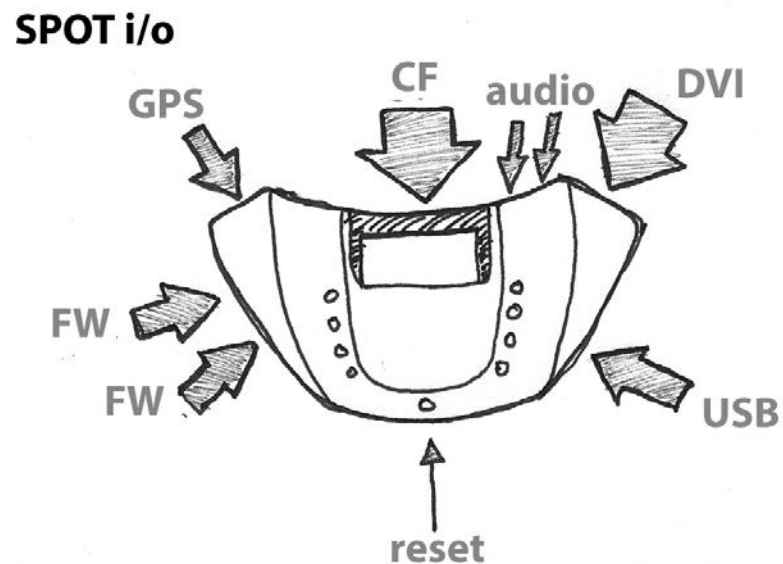
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Spot - Core Module Input and Output



I/O Interfaces:

- Firewire (FW)
- Digital Video Interface (DVI)
- Universal Serial Bus (USB)
- Audio
- Serial Interface (e.g. for GPS)
- Compact Flash (CF)



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Spot Specifications

	<i>Spot</i>
Processor	206MHz SA-1110
Companion Chip	SA-1111
Memory	256MB SDRAM
Flash RAM	64MB
PCMCIA	1 Type-II
CompactFlash	1 Type-II
Display	DVI 1.0 output
Serial I/O	1 RS-232
USB	1 type A
IEEE-1394	2 powered ports
power monitoring	14 channels
audio	stereo in/out



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Intelligent Battery Power Supply

- Dual lithium ion rechargeable battery packs
 - Total charge capacity: 2200mAh
 - 6 hour + lifetime
 - Usage assumptions: processor 100%, Microdrive 15%, WaveLAN 30%, LCD 75%
 - Can easily switch to higher-capacity cells
 - Hot-swappable batteries
 - Onboard charging circuitry
 - Li+ cells require discharge monitors
 - Includes 16-bit microcontroller to query monitors and report charge levels to the host processor
 - Information can be used to notify user to swap batteries, or for application tuning



Spot IEEE-1394 “Firewire” Power/Data

- Dual IEEE-1394 powered interfaces
 - Can supply 1.5A to 1394 bus devices
 - Will be used to add other modules to Spot system, e.g., UMTS and Bluetooth communications modules



ARM Architecture and StrongARM

- High-performance, low-power
 - StrongARM SA-1110: 450mW @ 206MHz
 - Intel XScale: ARM core at up to 1GHz
 - available Q4 2001
 - process shrink (0.18 μ) should keep power low
- High integration, clock throttling
 - PCMCIA, USB, audio control, LCD
 - SA-1110 clock adjustable from 59–206MHz



Spot System Software

- System Software
 - Linux 2.4 is up and running
 - patch against *2.4.1-rmk1-np2* merged
 - *www.wearablegroup.org/software/spot*
 - ARM Linux userland up and running
 - ext2fs ramdisk for testing
 - *www.wearablegroup.org/software/ramdisk*
 - *bootldr* support written
 - *www.wearablegroup.org/software/assabet*



Some Unique Features

- First StrongARM/Linux system with large memory (256 MB SDRAM, expandable to 512 MB)
- Separate display “accelerator” processor
- Built-in custom 802.11b radioLAN antenna
- First Digital Video Interface (DVI) wearable
- First Firewire wearable
- PC board designed to meet Intrinsically Safe (IS) standards for explosive environments



Spot Commercialization Status

- Third revision of Spot being completed in October
 - Final design and fabrication documentation available
 - Patented Wheel/Pointer design and fabrication documentation available
 - IBM HMD design documentation and intellectual property agreement in place for commercial production of HMD
- Inmedius working to commercialize Spot system through hardware companies
 - Sony, Casio, IBM, Symbol, HP, Toshiba, Xybernaut



Spot Delivery Schedule

- R3 Spots available early December
- Use iPAQ PDAs to augment software development and test (similar StrongARM hardware architecture and Linux system software)



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System Demos

- [China Lake Video](#)
- [Pax River Trial](#)

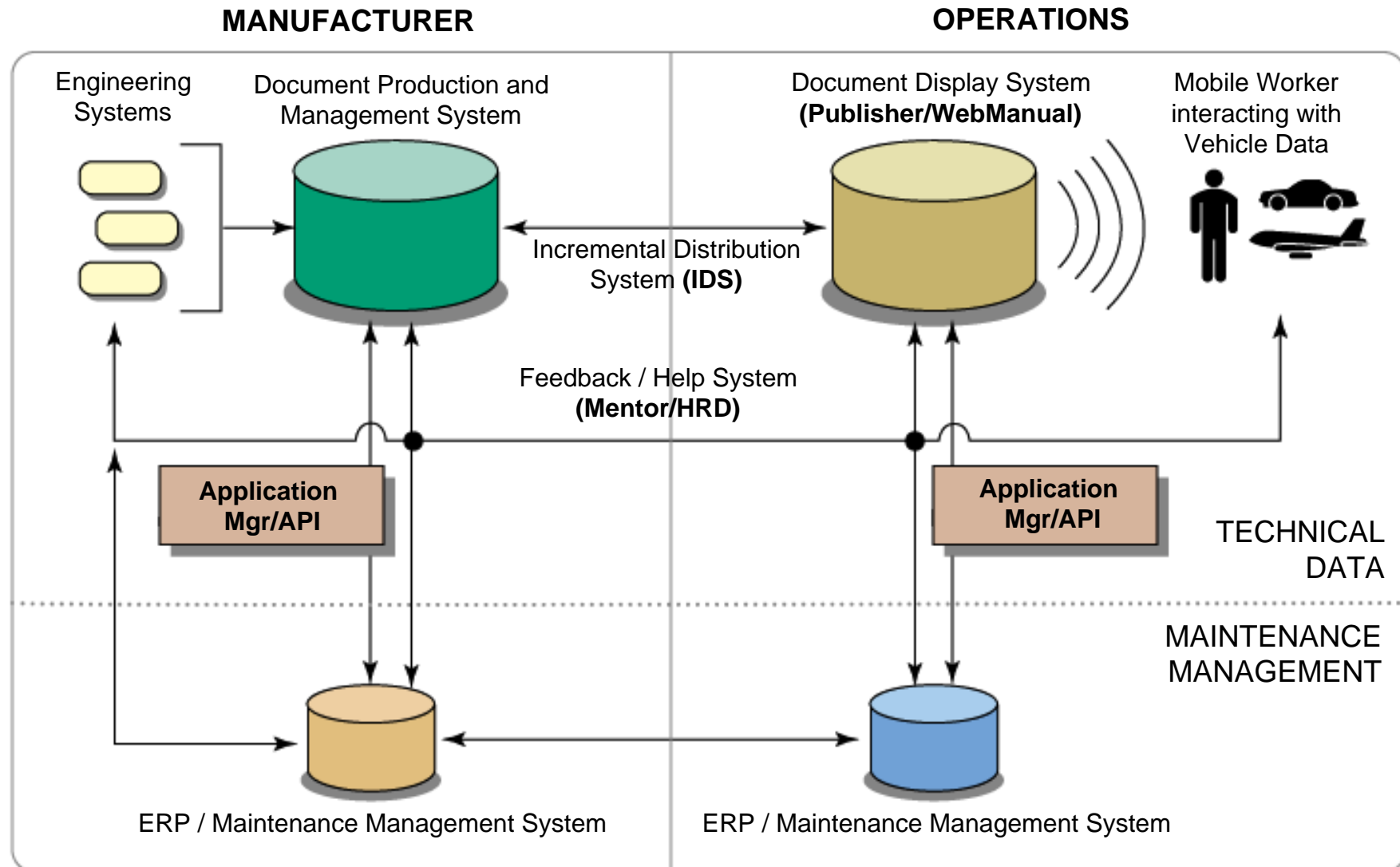


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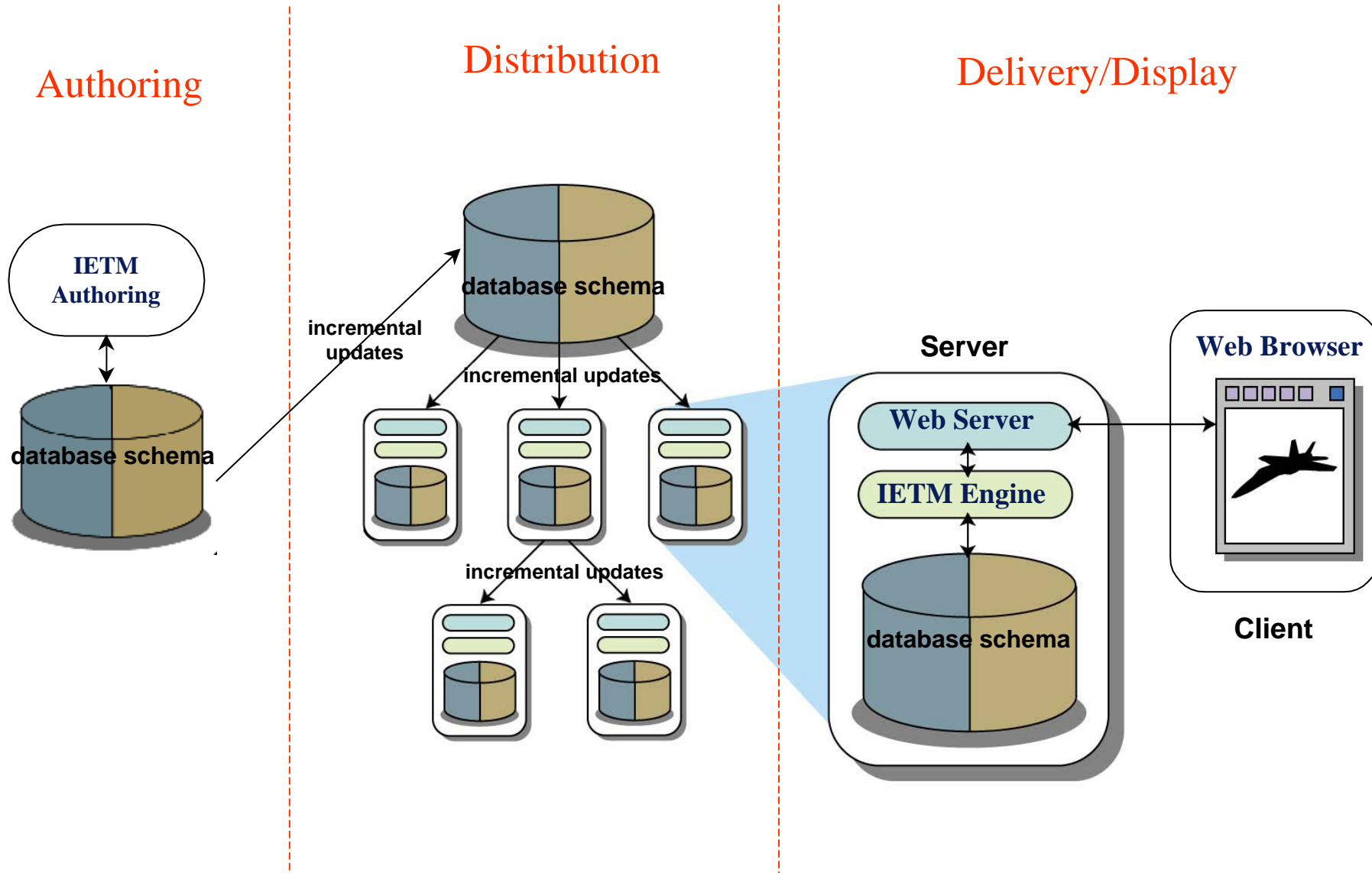


Concept of Operations





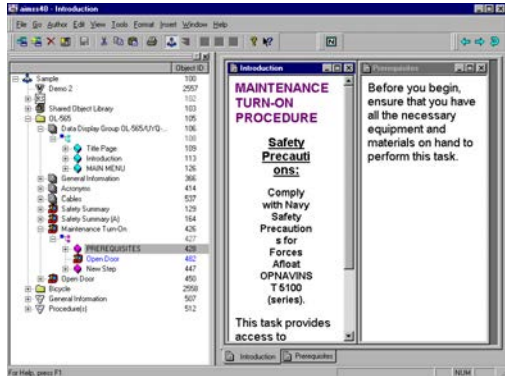
Inmedius Web-based IETM End-to-End Architecture





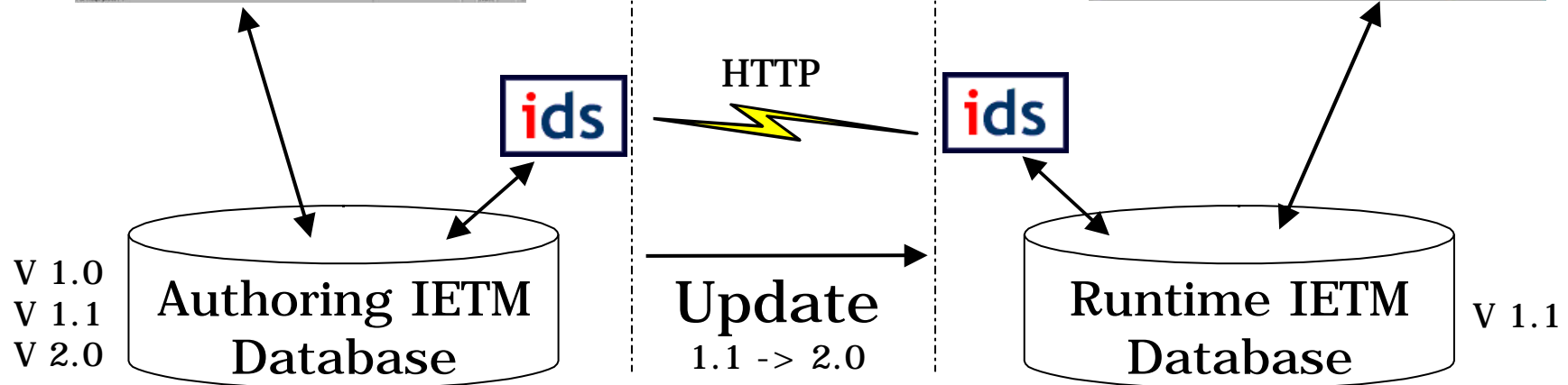
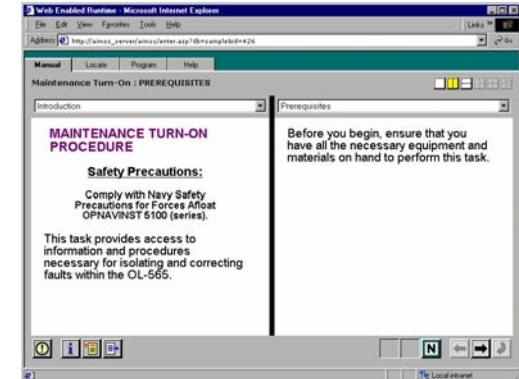
Inmedius Overview of IDS Operation

AIMSS Authoring



Internet

WebManual



- Limited bandwidth usage by sending only changes across
- Frequent updates can be done cheaply and accurately



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Mentor/HRD Functions

- Mentor helps technicians to correctly diagnose and efficiently solve a problem by:
 - electronically documenting the problem and its resolution
 - visibly managing the problem via a simple workflow
 - enabling the technician to contact remote engineering experts
 - allowing the remote engineering experts to see the problem
 - giving all users access to the problem using just a web browser
 - searching a library of previous problems
 - ensuring the root cause of the problem is documented for eventual rectification

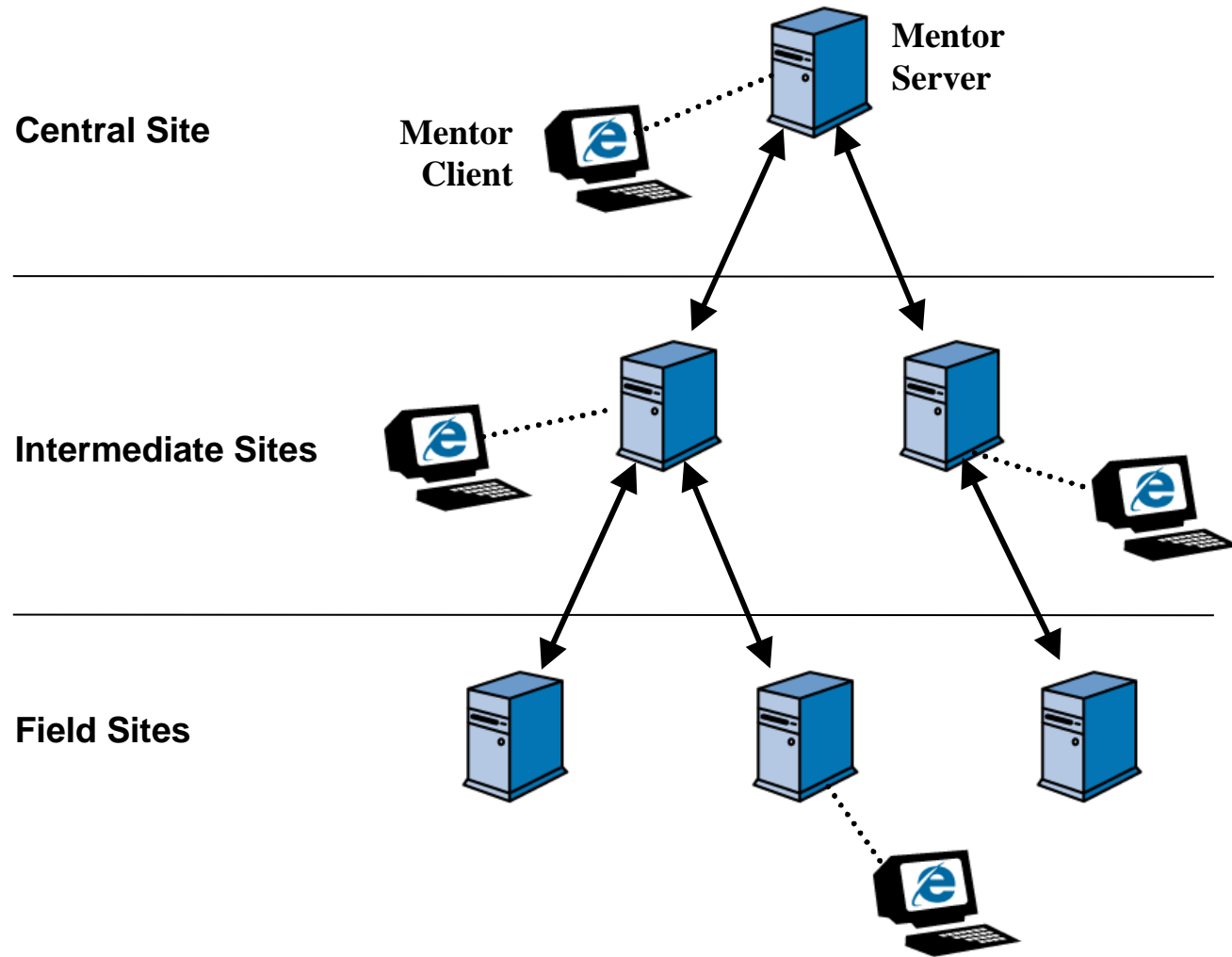


Inmedius Mentor Help Request Documents

- An online, evolving collection of
 - text
 - captured sounds
 - still images and sketches
 - mix of required and freeform fields
 - chat logs
- HRDs are
 - created using a simple wizard that guides technicians in collecting the necessary data
 - tracked in a local workflow
 - replicated from local origination to remote experts
 - stored in a searchable virtual library



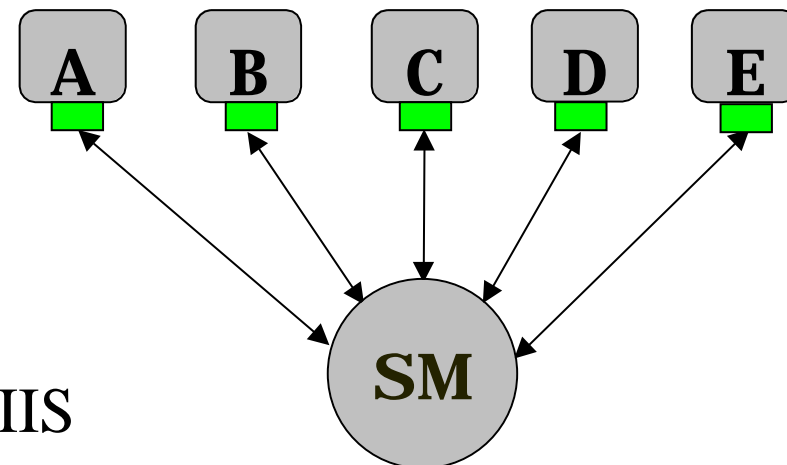
Inmedius Inter-networked Mentor Servers





Application Manager Features

- Legacy applications behave as if developed as integrated system
- Executes as a Windows NT service
- Guaranteed delivery of messages via a robust, reliable mechanism
- API is a Microsoft COM component; facilitates access from any MS language
- Supports distributed message propagation via peer-to-peer HTTP communication (any topology)
- Self-contained HTTP server vs. IIS

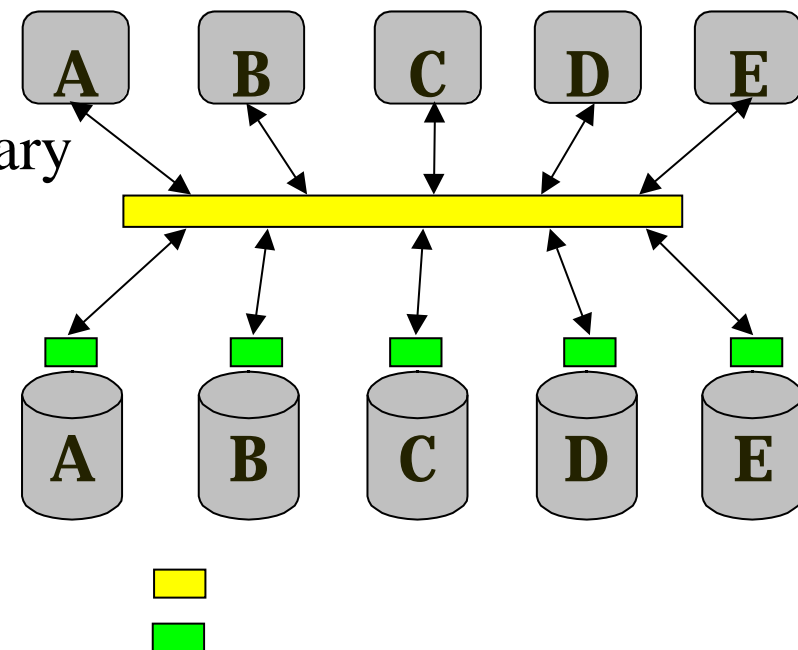


 API
 Component Interaction



Generalized Database API Features

- XML inputs and outputs
- XML conforms to customer-based DTDs
- API calls chosen for completeness, used by application components
- implemented using DBMS programmer API and DBMS stored procedures
- provides *integrated* view of integrated system proprietary databases to application components





Summary

- Maintenance of mass customized products is an important real world problem
- I have expectations that this class will produce innovative system capabilities in the TRAMP projects
- I'll be back