TRAMP Problem Statement

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Inmedius, Inc. and

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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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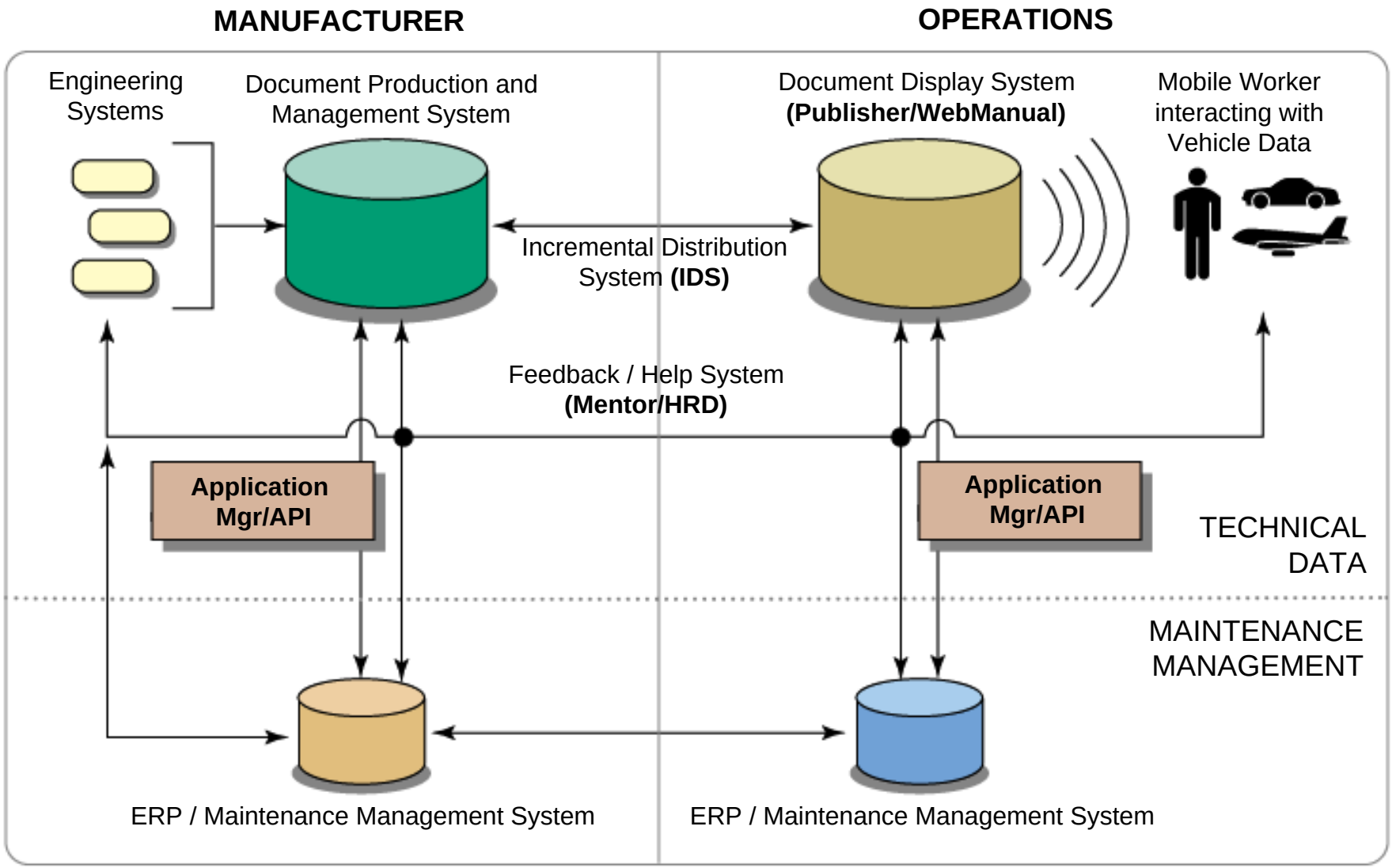
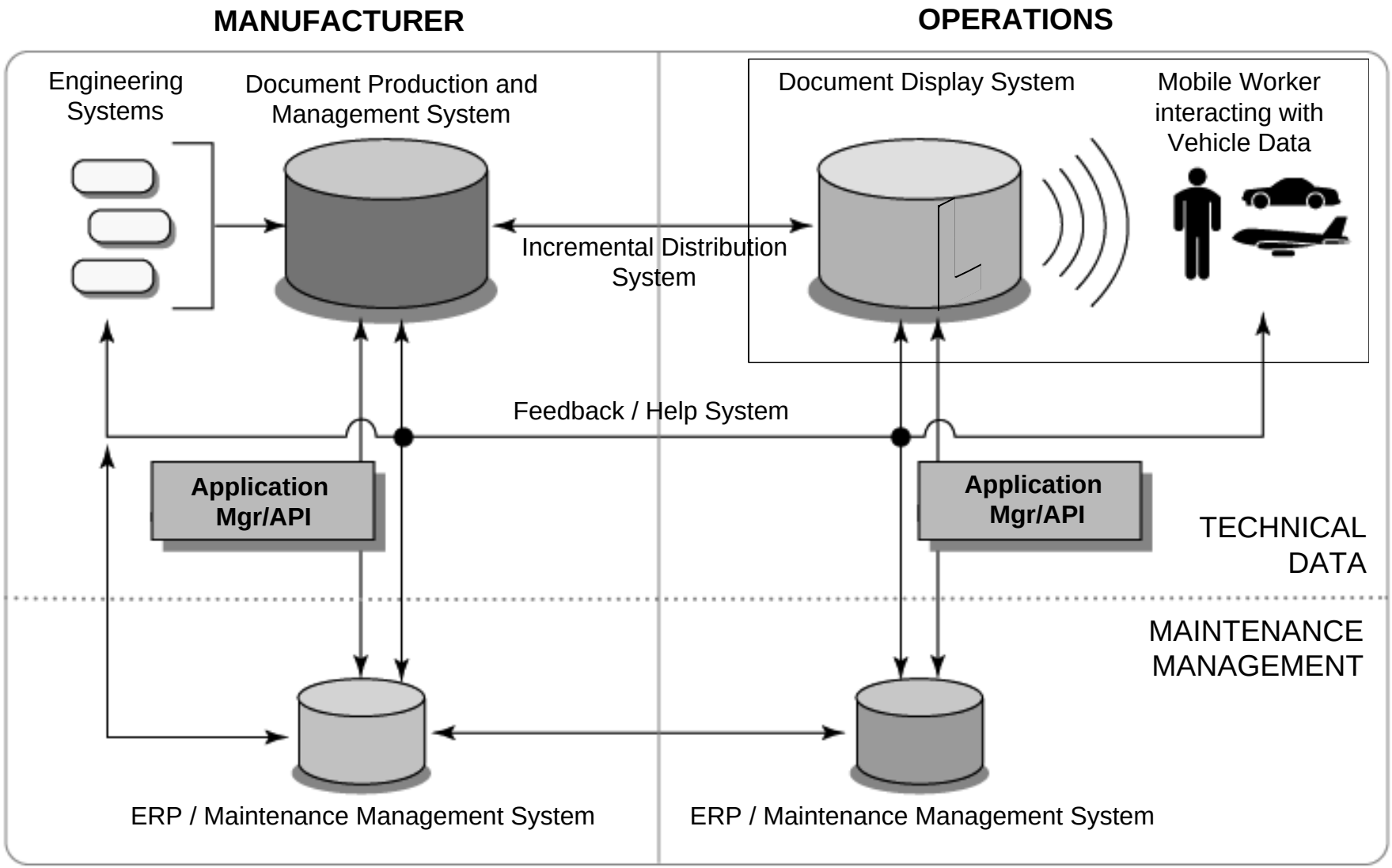
Concept of Operations



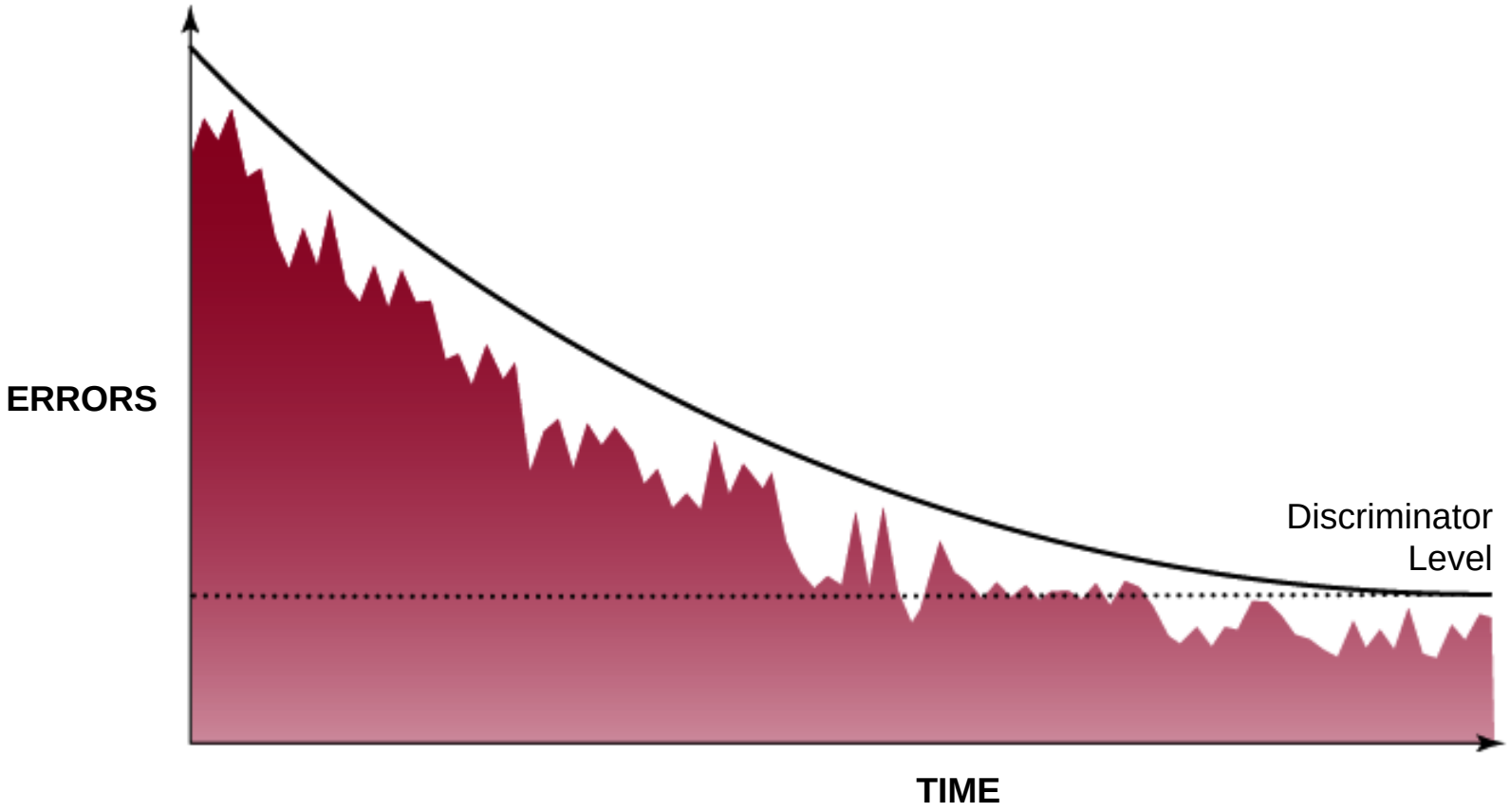
Concept of Operations



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



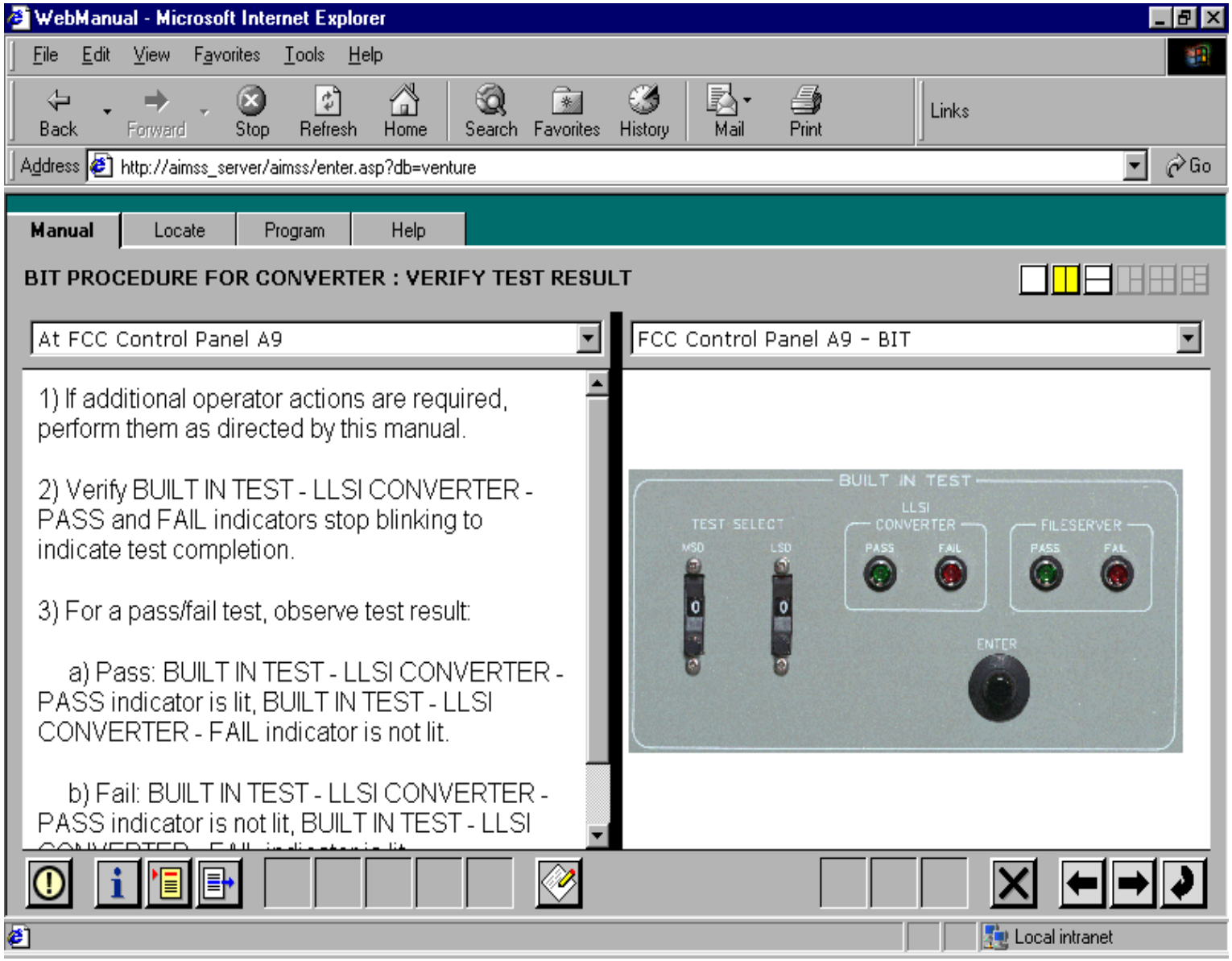
Why Interactive Electronic Tech Manuals (IETMs)

- "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

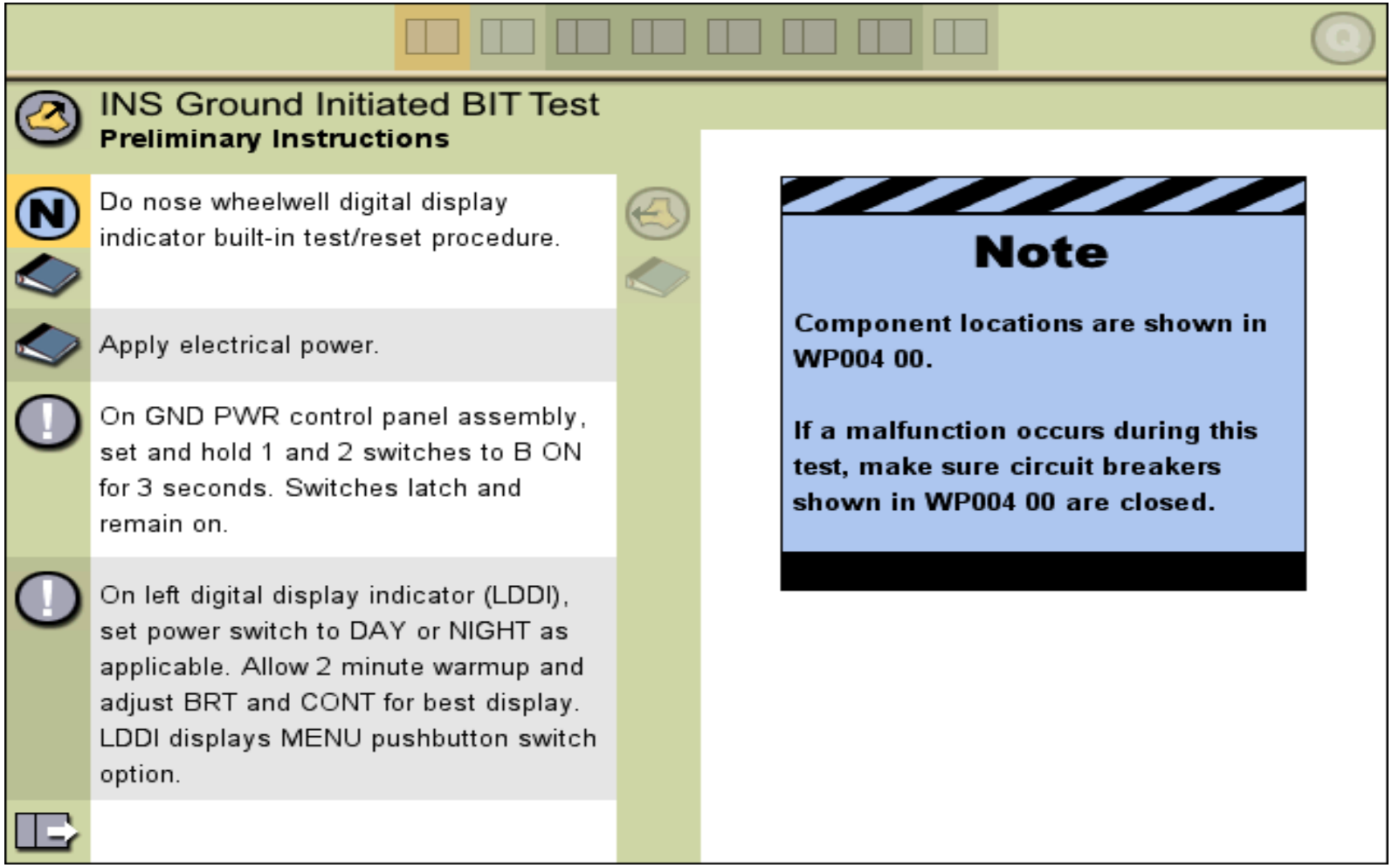
- **Class 1**: View full page image with index to pages
- **Class 2**: Scrolling text with hot spot links to other data
- **Class 3**: View tagged documents through smaller logical blocks of text and graphics with less scrolling
- **Class 4**: Data authored to data base for dynamic, interactive output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



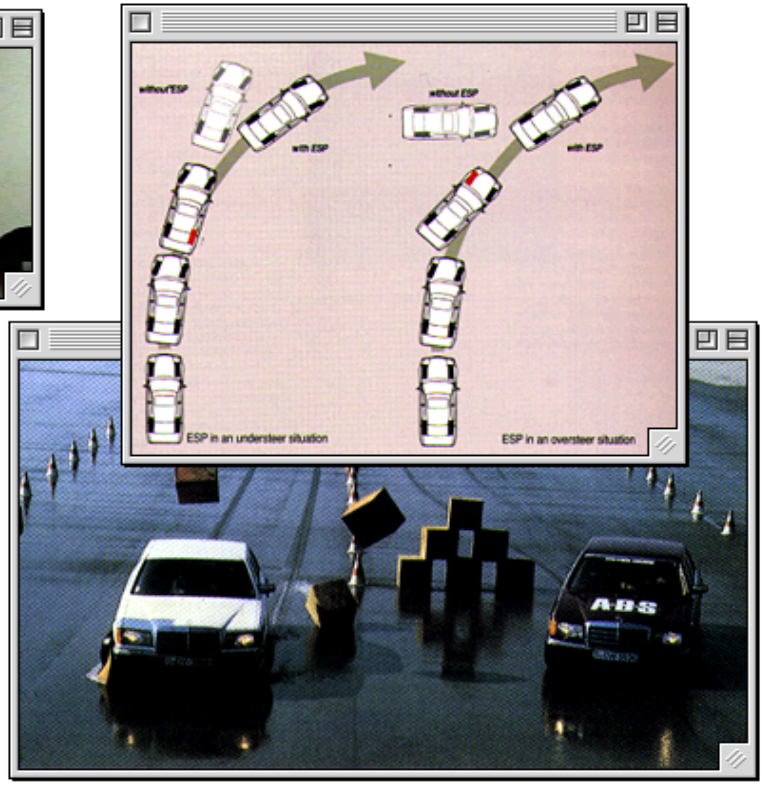
Selection of IETM “hot links” with Wheel/Pointer

Next-generation IETM User Interface



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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TRAMP scenario

- 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”.

TRAMP scenario - 2

- 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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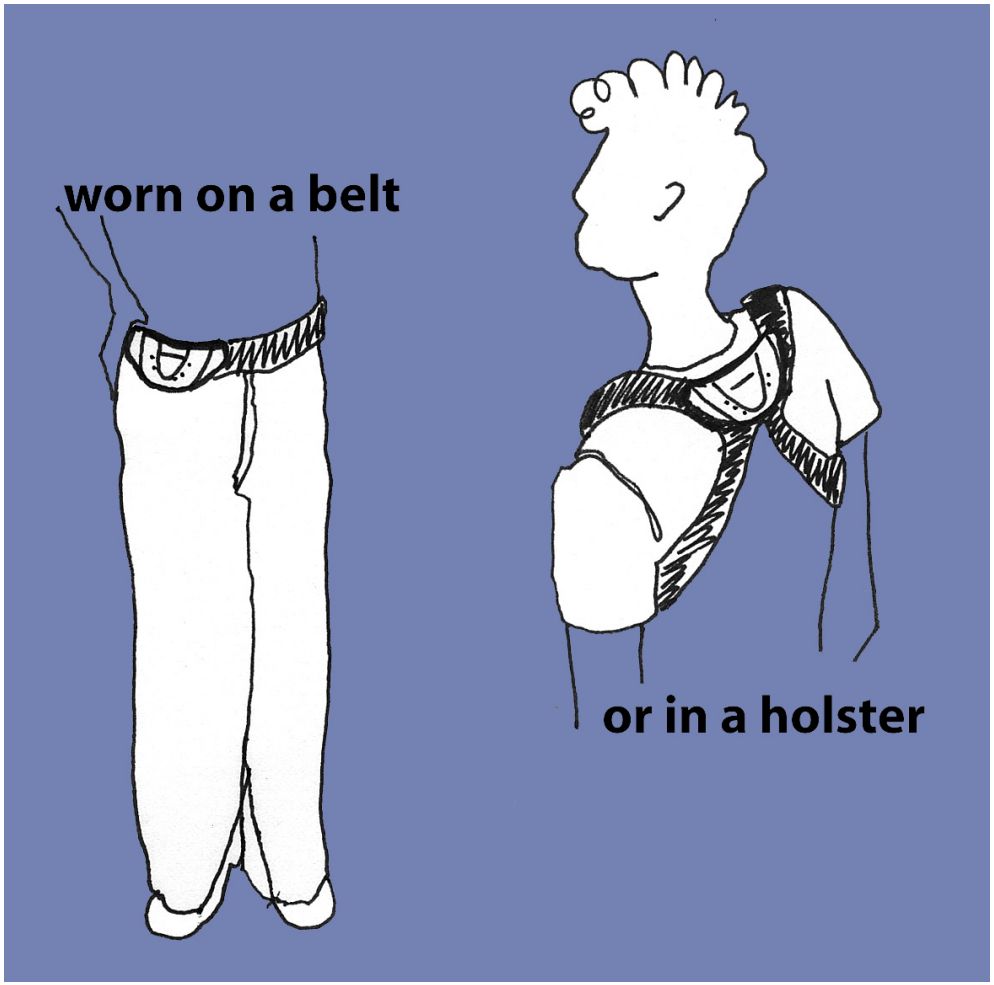
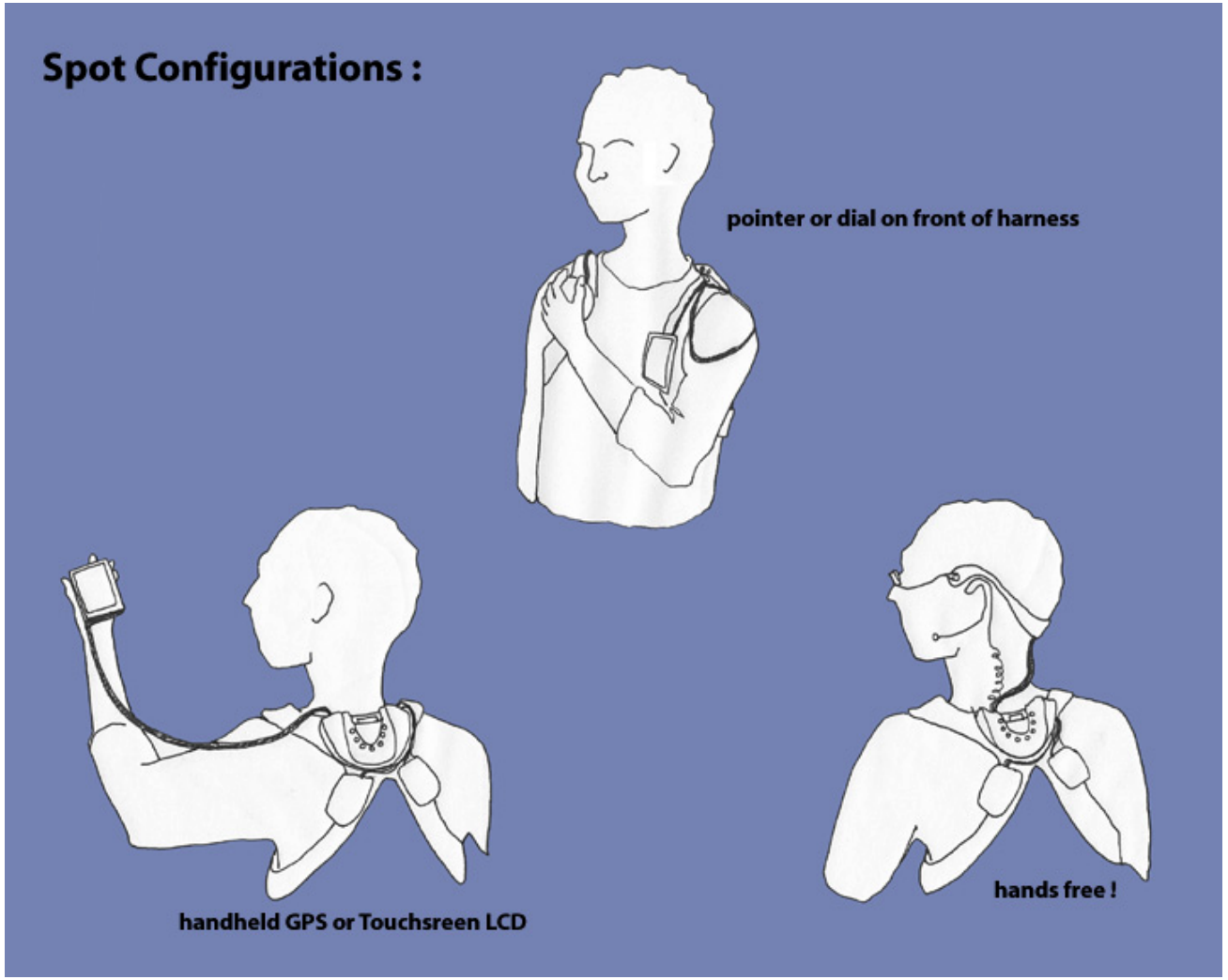
Spot - On the Body

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



Configured for Any Task or Interaction Model



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

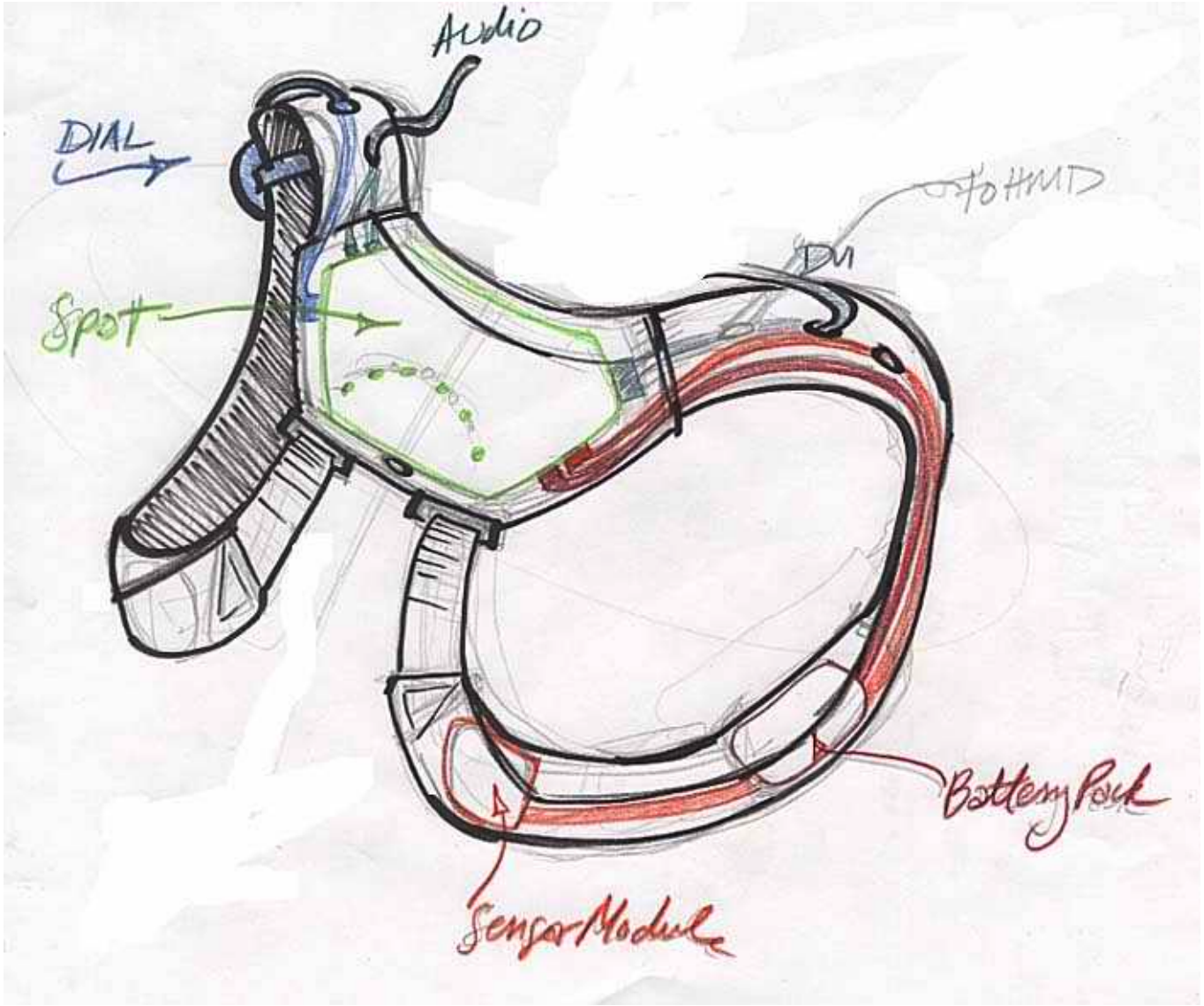
IBM Head Mounted Display (HMD) Details

• 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

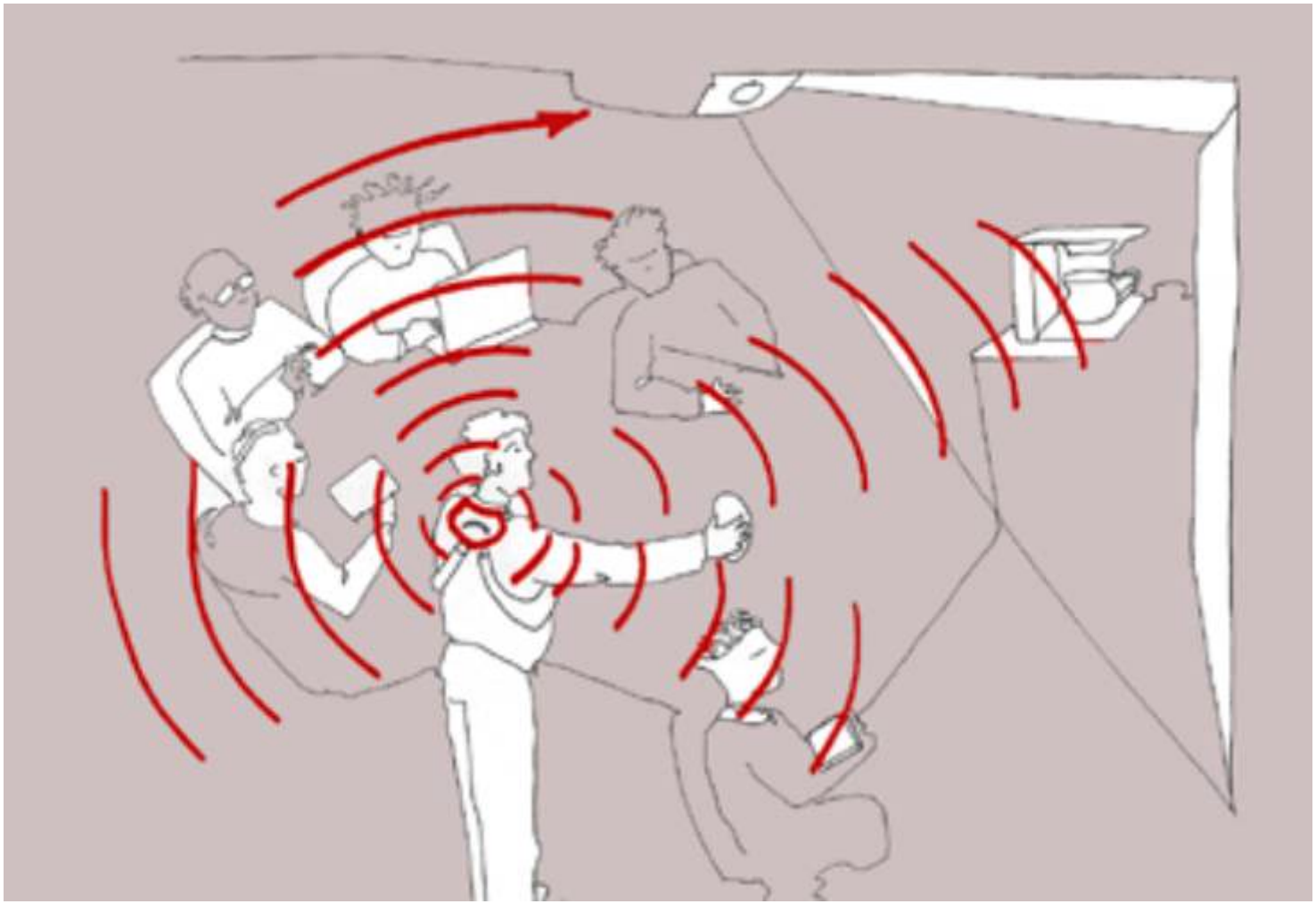
Spot Context Sensitive System Configuration



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

Spot Operation of Consumer Objects



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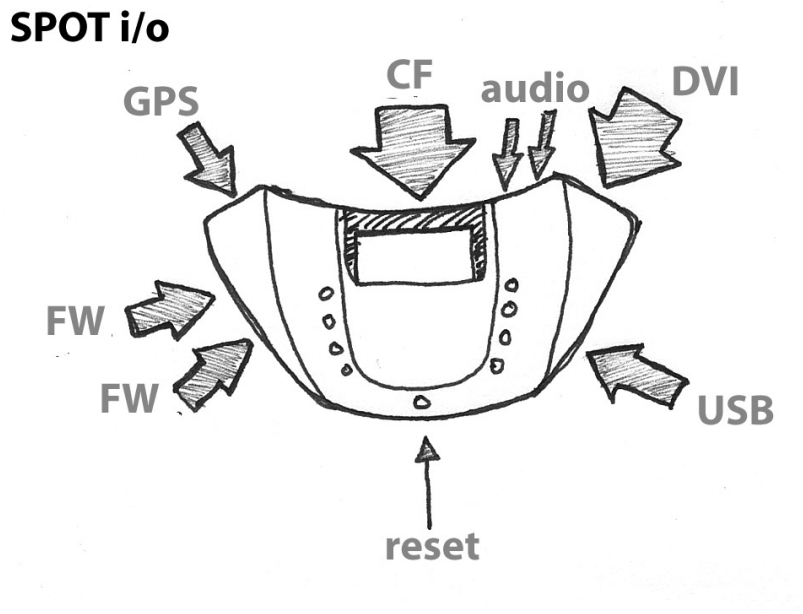
Spot - Core Module Input and Output



I/O Interfaces:

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

Spot Specifications

	Spot
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

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 (0.18µ) 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)

System Demos

- China Lake Video
- Pax River Trial

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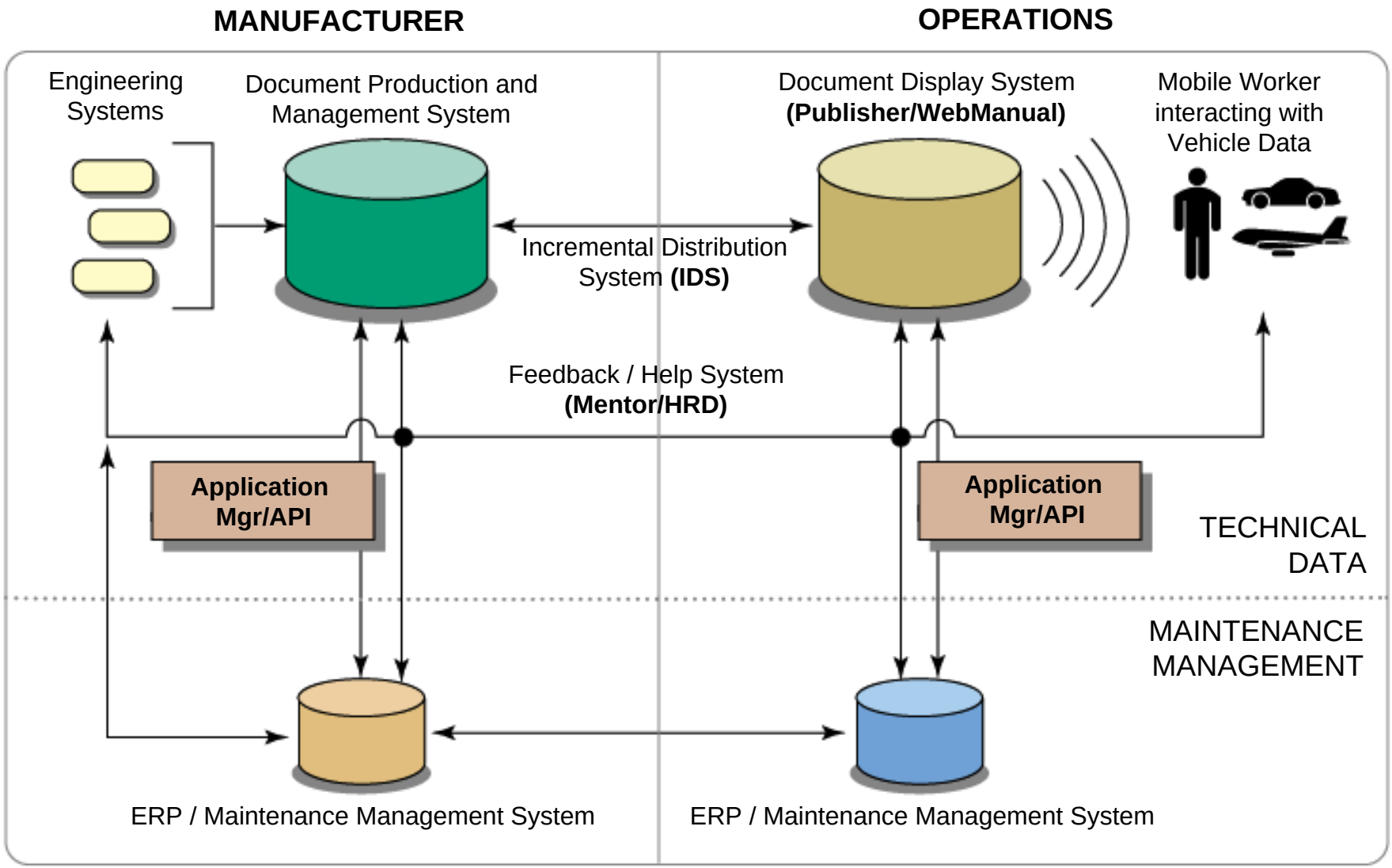
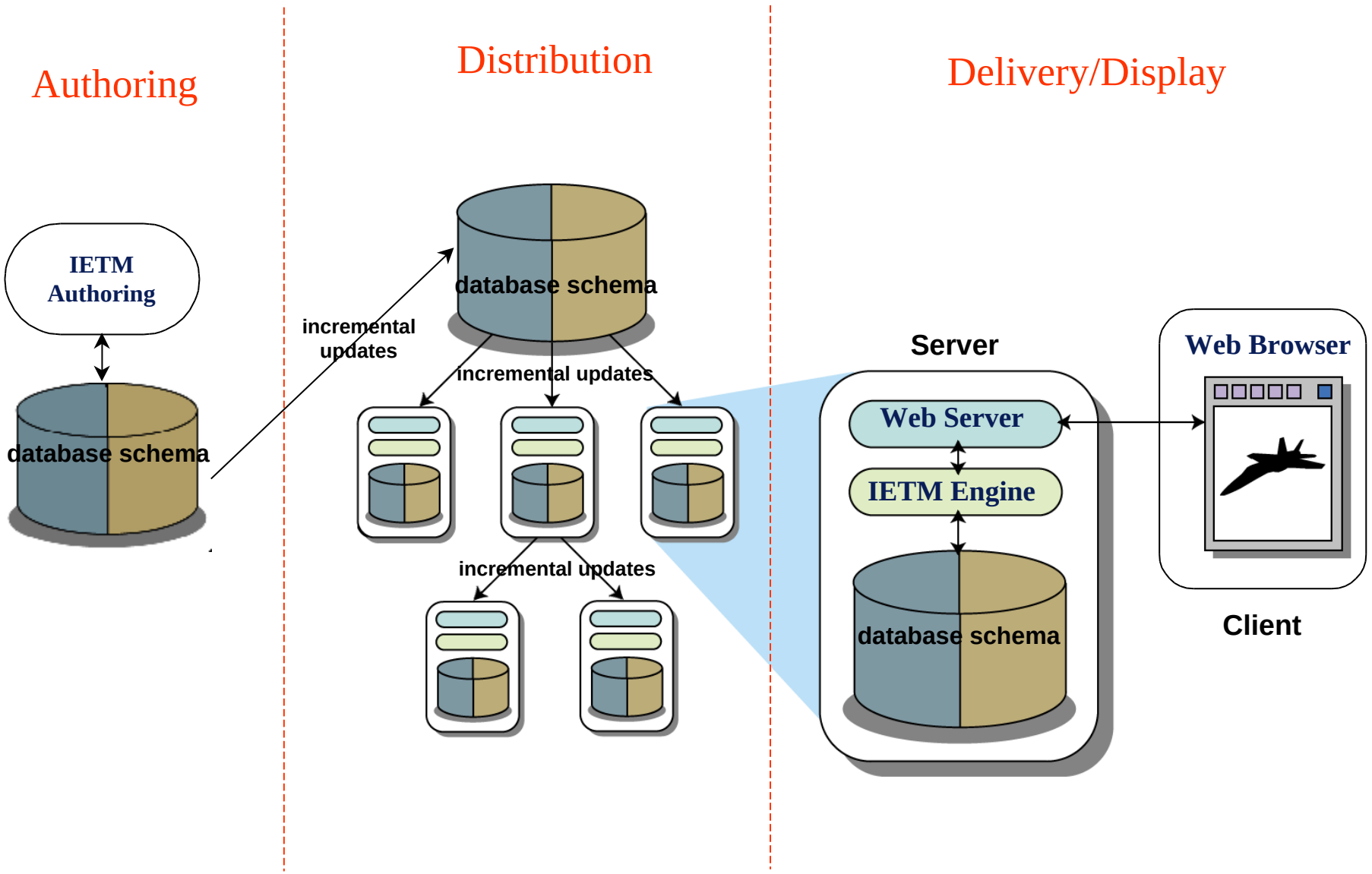
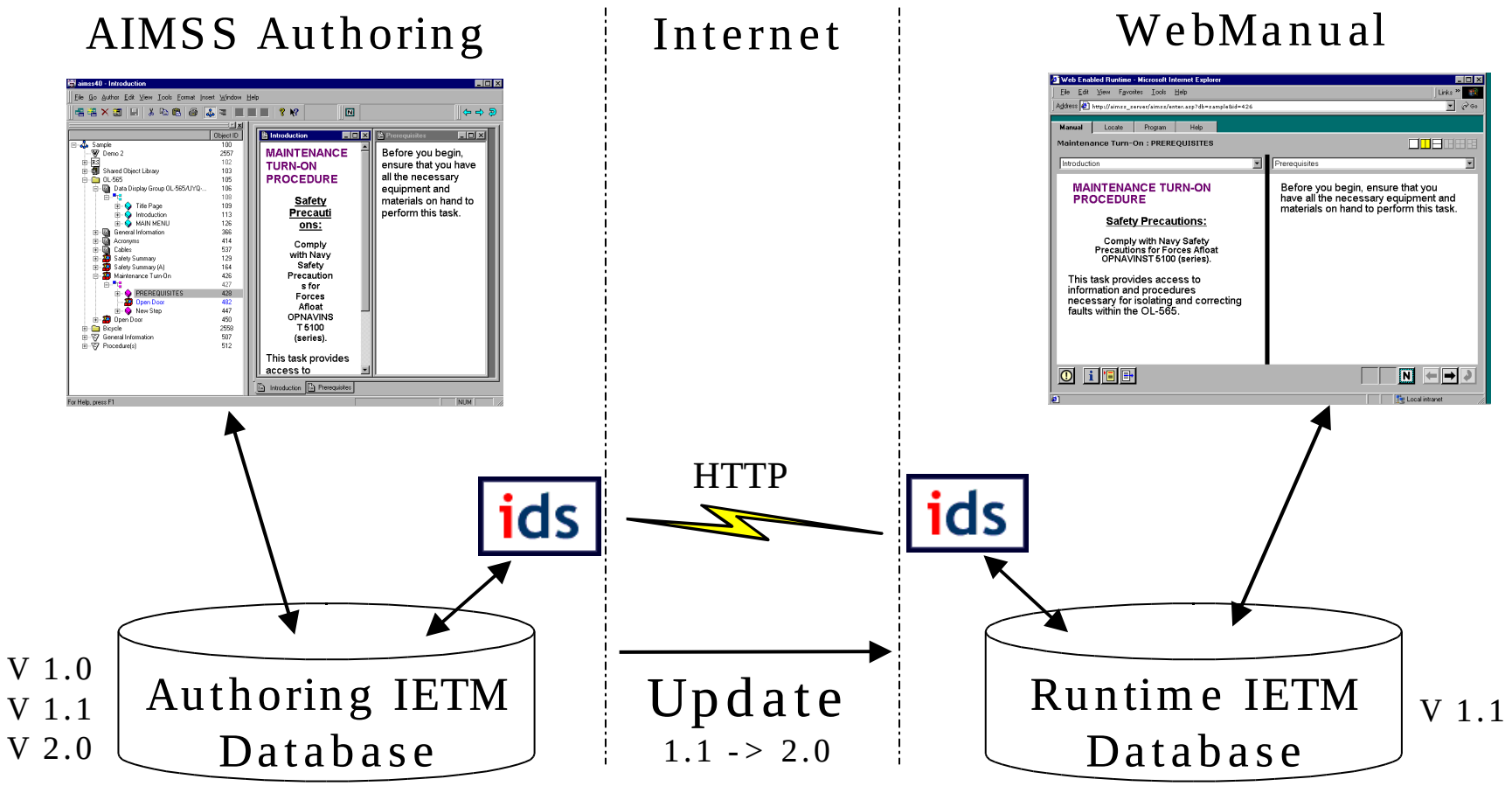


Inmedius Web-based IETM End-to-End Architecture



Inmedius Overview of IDS Operation



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

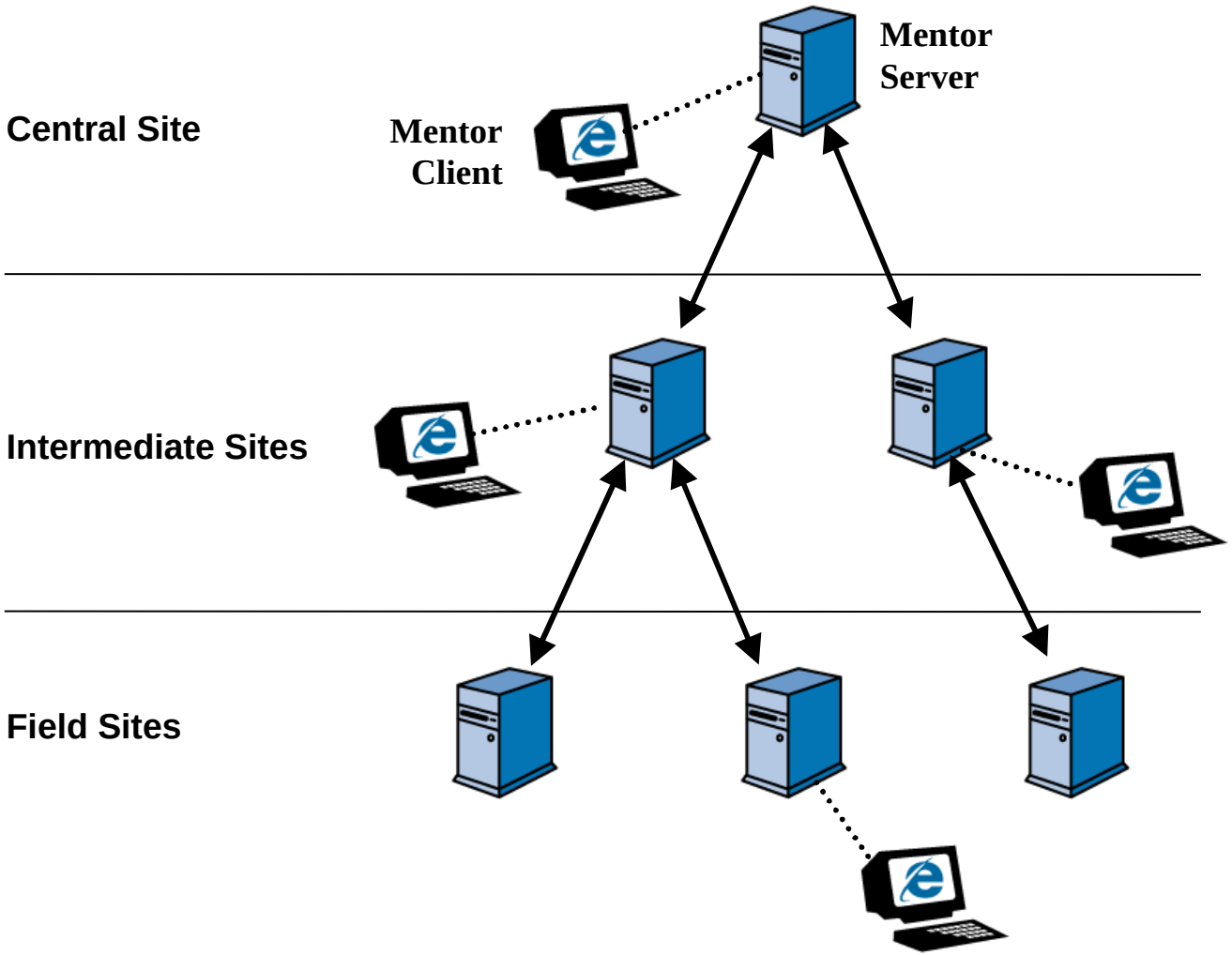
Mentor/HRD Functions

- 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

Mentor Help Request Documents

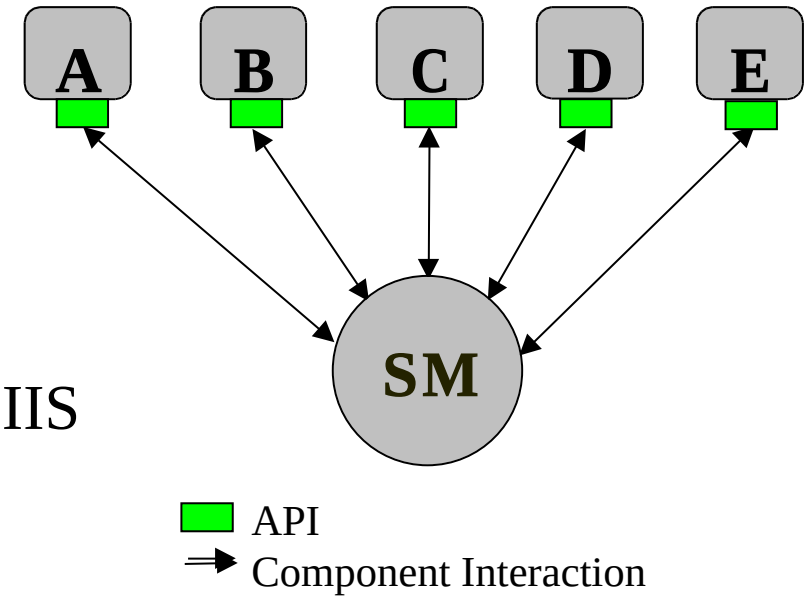
- An online, evolving collection of
  - text
  - captured sounds
  - still images and sketches
  - mix of required and freeform fields
  - chat logs
- HRDs are
  - created using a simple wizard that guides technicians in collecting the necessary data
  - tracked in a local workflow
  - replicated from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

Inter-networked Mentor Servers



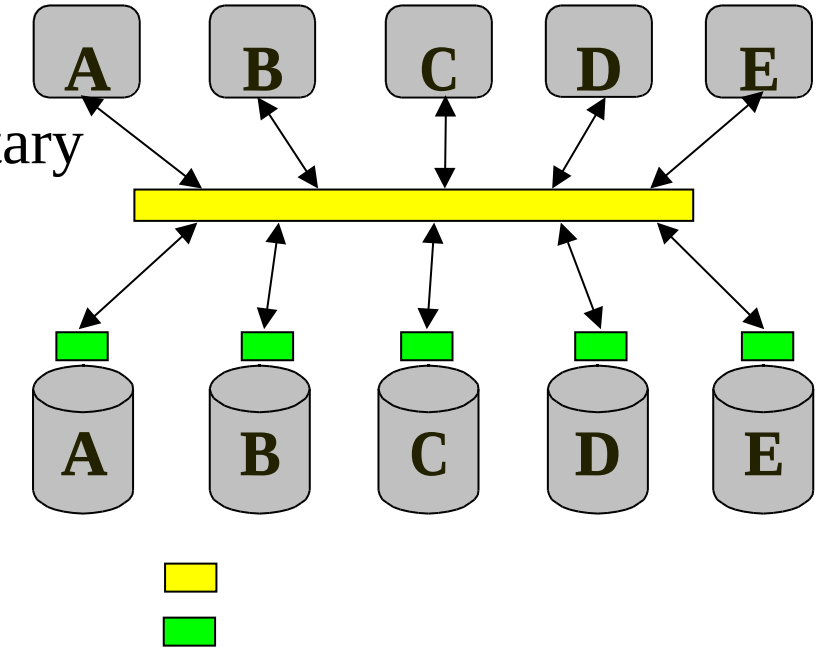
Application Manager Features

- 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



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