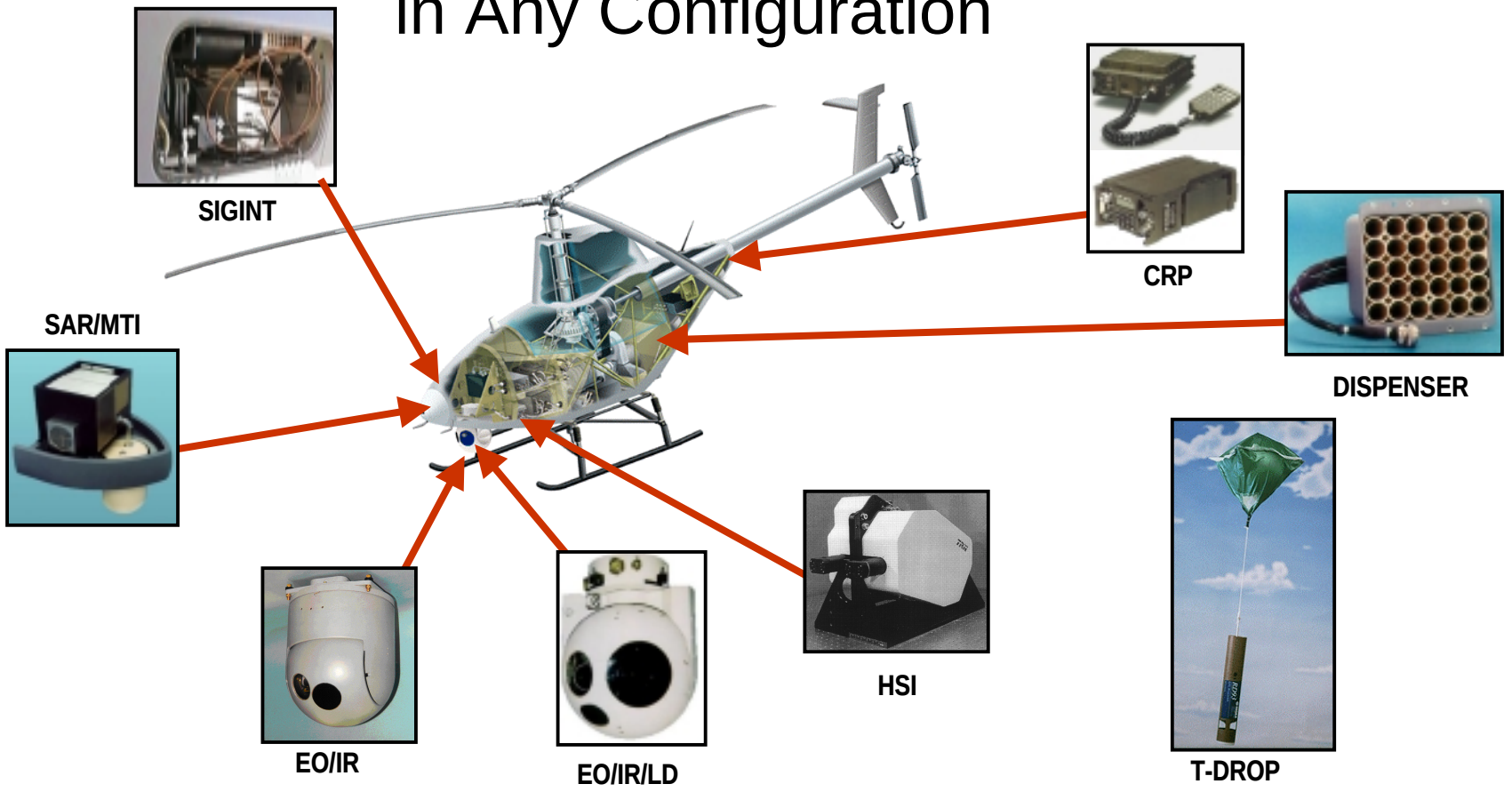
Modular Mission Payloads Architecture Concept & Demonstration

The Dilemma

Any Payload in Any Vehicle in Any Configuration



Current UAV Architecture

MMP Control & Status Separated from AV C&S and Routed to MMP

Analog Payload Video

Gimbal Slew
Camera Control
Laser Control
Video

Payload Control

TCDL ADT

AV & MMP Control/Status

Air Vehicle Mgmt. System

AV Control

NAV System
Air Vehicle Control Actuators & Sensors
Automatic Landing System
Comms, etc.

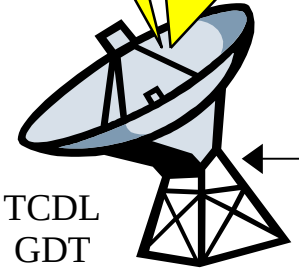
AV

GCS

AVSI Converted to Aircraft and MMP Specific Commands

TCS Core

MMP Control & HCI Embedded



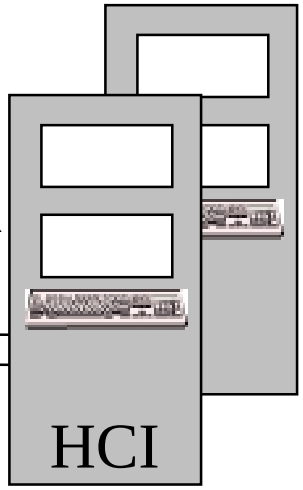
TCDL GDT

DCP

AV & MMP Control/Video In AVSI

Real Time Subsystem

LAN



HCI

C4I

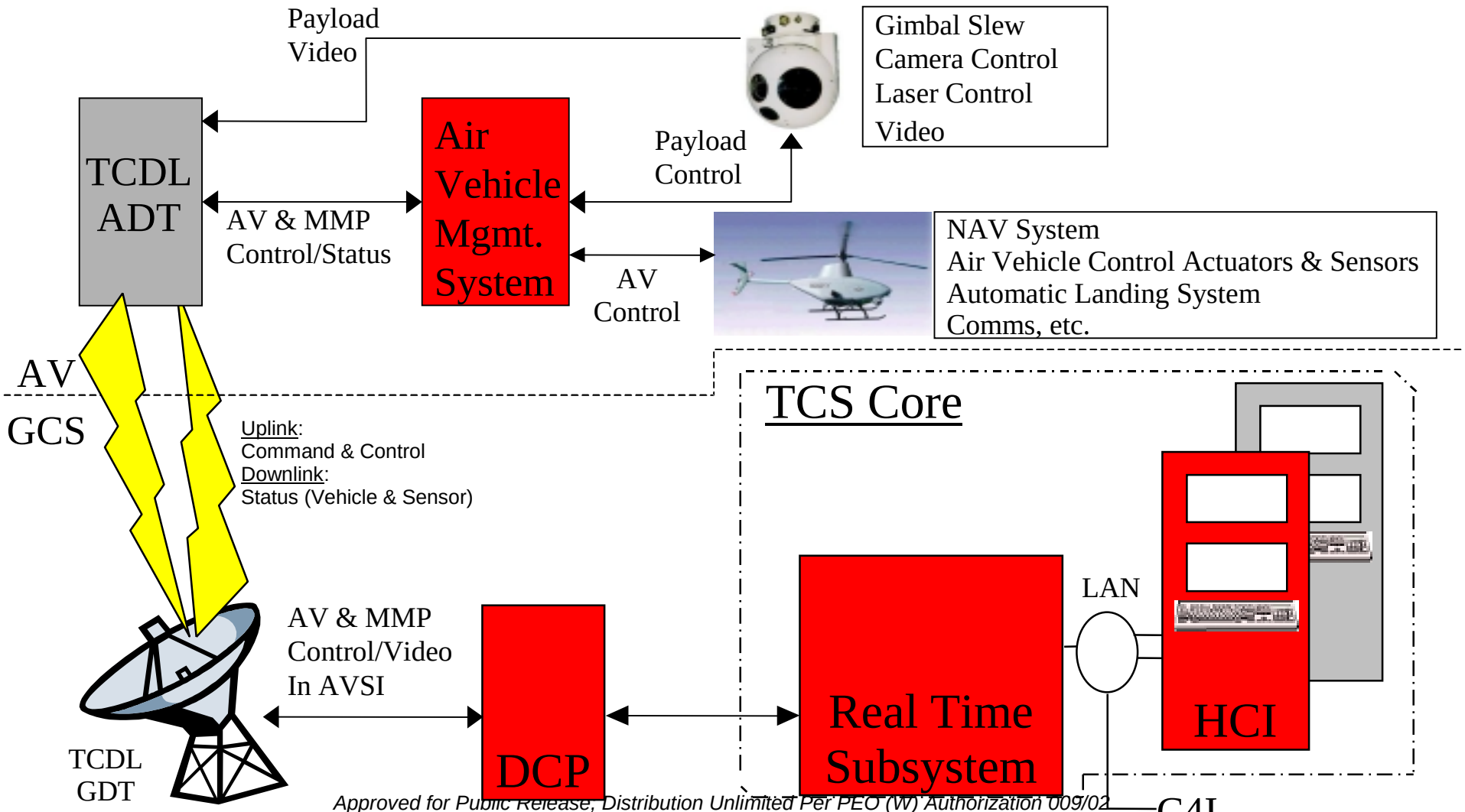
Limitations With Current UAV Architecture

- Limited Growth Potential
  - Restricted By Existing AVSI and A-G IDD
  - Extensive Modifications To Airborne and Ground System Software For Each New Payload
  - Combined AV and Payload control data paths through VMC
    - Significant constraint on adding new payloads due to flight clearance issues, regression testing, etc.
- Restricted Configuration Of Payloads
- Reduced Interoperability / Compatibility
  - Proprietary And Non-Standard Payload Formats
  - Payload-to-Payload Communication

Current Integration Challenges of New Payloads

- Full Integration of “New” Payloads Into a UAV System Requires:
  - Modified Version of GCS/TCS
    - Possible Modification / Amendment to AVSI
  - Modified DCP S/W
  - Modified AV S/W
  - Regression DT / OT of All Software Items
  - Likely to Require Full Safety of Flight Re-Certification!!

Software Changes for Payload Integration



PnP Goal

Maximize Mission Flexibility / Effectiveness while Minimizing Total Ownership Cost

	CURRENT	PnP
Design Flexibility	Baseline proprietary, looking for P3I, but requires system mods	Any MMP designed to ICD, incorporating Wt-Vol-Pwr-Interface reqmnts
Mission Flexibility	Baseline MMP mission (EO/IR/LDRF)	Multiple missions tied to ORD, CONOPS, new technologies, etc.
Flight Cert & NRE	New MMP? Entire system re-cert, NRE required to integrate	Limited flight re-cert, minimize NRE
Interoperability & Commonality	Stovepipe w/ proprietary information	Navy systems, Joint systems, C4I, etc.
Cost	Higher TOC due to Config / ICD / flight testing for each new MMP	Reduced TOC for each new MMP, due to up front integration for PnP

Concept Exploration

- Explore One Possible Implementation
  - Evaluate That Particular Implementation
  - Prove Feasibility
  - Evaluate Human Factors Issues
  - Uncover Challenges
  - Work Towards a Truly Open Architecture for Payloads and New Mission Capabilities

All Leads to Better Defined Requirements

Demonstration Concept

- Use Web Server - Browser Approach
  - Payload-only Data Path and Processing
    - Minimize MMP -Related Code From Ground Control Station (GCS) & Vehicle Management System (VMS)
  - Excellent Graphical User Interface
- Use Payload Interface Controller (PIC) in Air Vehicle
- GCS Is Browser With Plug-ins
  - Software Configuration Remains Constant

Patent Pending

PnP Architecture Concept

Separate Drivers for Each MMP

High Speed Data Bus / Network

Payload Interface Controller (PIC)

Legacy Interfaces

P3I MMP

P3I MMP

P3I MMP

MMP Control / Data

TCDL ADT

Patent Pending

NAV Data

Vehicle Mgmt. System (VMS)

NAV System
Air Vehicle Control Actuators & Sensors
Automatic Landing System
Comms, etc.

AV Control

AV Control

AV GCS

Uplink:
Command & Control
Downlink:
Data (Vehicle & Sensor)

TCS Core

Web Browser With Plug-ins

MMP Control/Video

LAN

HCI

TCDL GDT

AV Control

DCP

AV Control

Real Time Subsystem

C4I

Concept Architecture
Benefits

- Payload Software Physically and Logically Separate From Flight Control
- Payload Software Located in One Configurable Item
- Legacy System Support within Future Interface Architecture
- Scaleable Architecture

Concept Architecture
Additional Benefits

- Ability to Maximize Use of Bandwidth
  - Control of Video Encoding / Compression
- Multiple Payload Control / Coordination
- Payload Hand-off
- Ease of Integrating New Payloads
  - Using Documented Open Standard Interface
  - Commercial Operating Systems and Applications for Designing GUI

Payload Interface Controller

The Key Enabler

- Enables Web-centric Architecture
  - Ethernet Connectivity
  - Web Server
  - Open Systems Architecture
- Standard Interfaces
  - MIL Connectors
- Growth Potential

Patent Pending

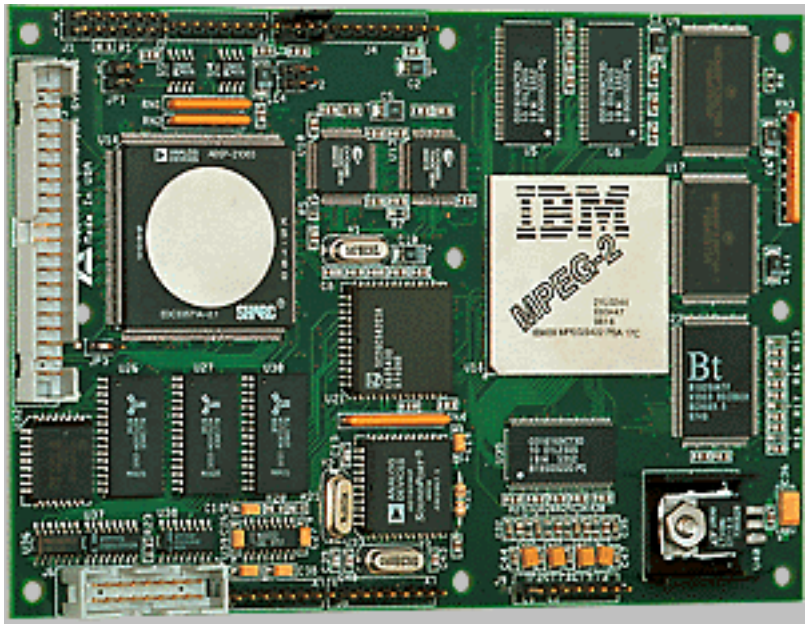
Payload Interface Controller
Hardware

- PC-104-Plus Based Hardware
  - Based on PC (Intel) Architecture
  - Self Stacking Bus / No Backplane
  - 3.55” x 3.775”x0.65”
- All Circuit Boards Off-The-Shelf
  - Real Time Devices Vendor for Most Circuit Boards
    - CPU, Communications/Ethernet, VGA, Hard Drive

Patent Pending

Video Encoding
Hardware

- MPEG-2 Transport Stream Encoder
  - Manufactured by Delta Information Systems
  - Converts RS-170 to Serial MPEG-2 TS Over RS-422
  - Not PC-104 Form Factor
  - Capable of Inserting Digital Metadata Into Transport Stream



- Requires High Speed Serial Interface
  - Manufactured by Commtech Fastcomm
  - 10 Mbit/second Data Transfer Rate

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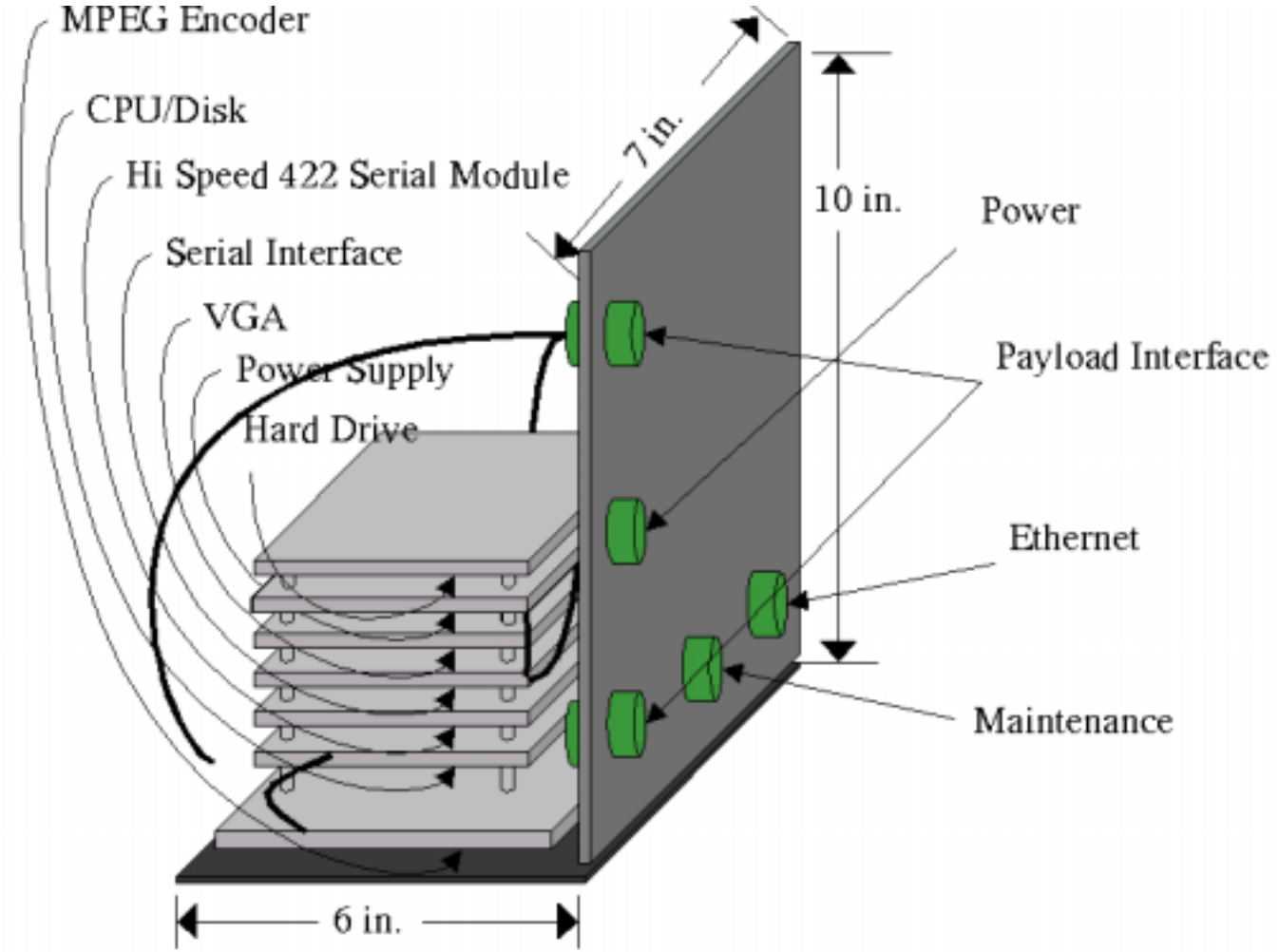
Payload Interface Controller

Prototype Configuration



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PIC Software
Networking Structure

- Standard IP Addressing
  - Air and Ground Networks Have Unique Subnets
  - PIC Uses TCDL ADT As Gateway to Ground Station Subnet, Client Uses TCDL GDT As Gateway to Aircraft Subnet
  - IP Addresses Designated for Internal Networks
- TCP/IP Protocol for Command & Status
- UDP/IP Protocol for Video

Patent Pending

PIC Software
Plug & Play Building Blocks

- Identify
  - Runs at Boot
  - Identifies Payload by Looking at data Stream
  - writes configuration file for PIC Executive and Java Client
- PIC Executive
  - Initializes Inter-Process Communications (IPC)
  - Begins PIC Processes
  - Assigns Logical Identifiers (LIDs)

Patent Pending

PIC Software

Payload Control

- PIC Processes
  - Wescam - Converts Java Client Data to RS-422 Serial Data Using Hand Controller ICD
  - TDROP - Converts Java Client Data to RS-232 Serial Data Using TDROP Dispenser ICD
    - Three Data Sets - GPS, Nova, Vaisala
  - MPEG2UDP - Reads MPEG TS From HS Serial and Sends to Client in UDP/IP Packets
    - Obstacles with Frame Synchronization and bit order

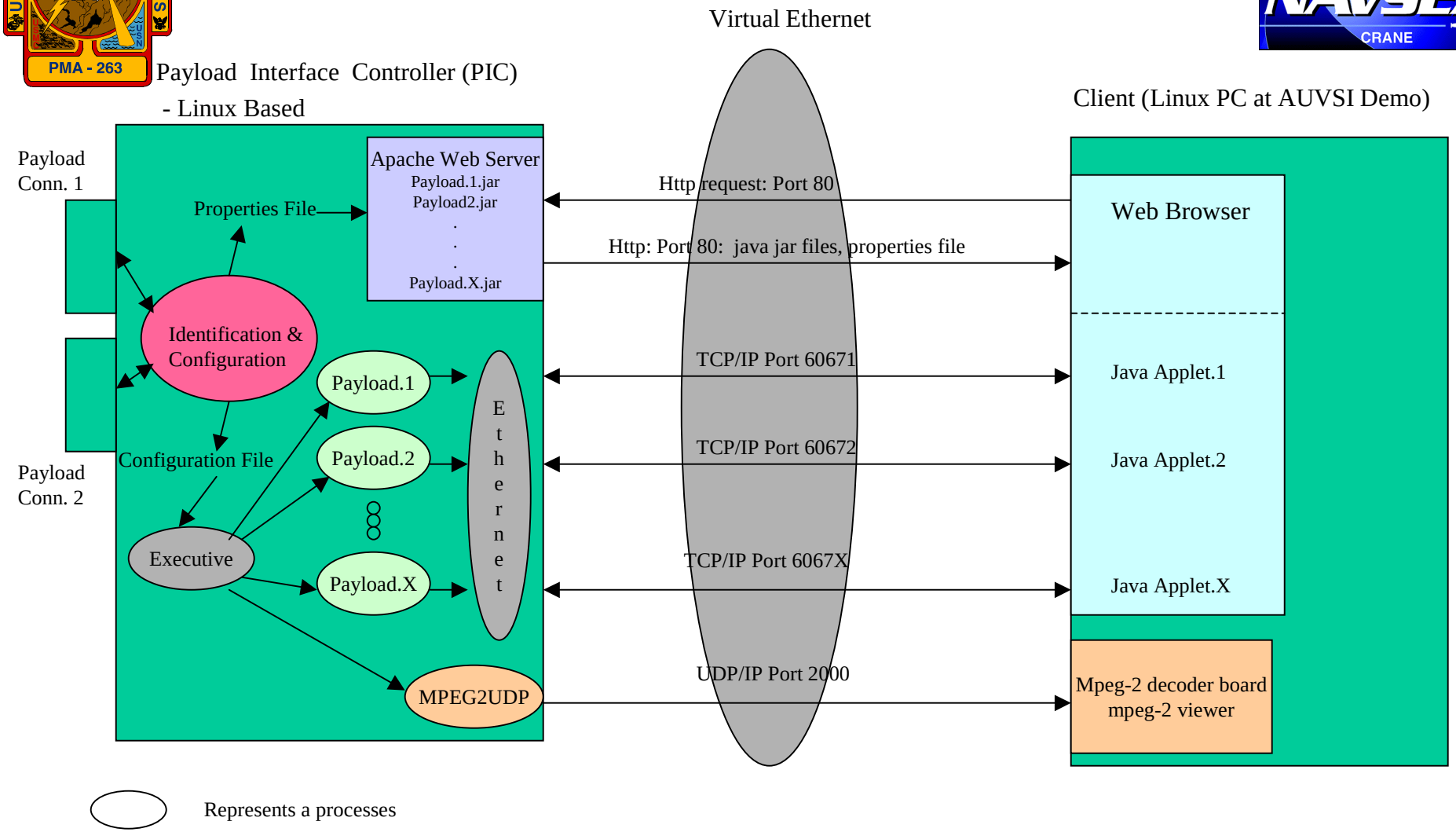
Patent Pending

PIC Software
Payload Control

- Java Client Software
  - Apache Web Server
  - HTML Interface - Downloads Client Software using APPLET Tag.
    - Supported by Netscape and Internet Explorer
  - Payload Properties Files - Contains information defining payloads and TCP Port Assignments
  - Payload Panel Classes - Defines GUI
  - Network Message Handlers - Communicates with PIC

Patent Pending

Multi-Payload Control



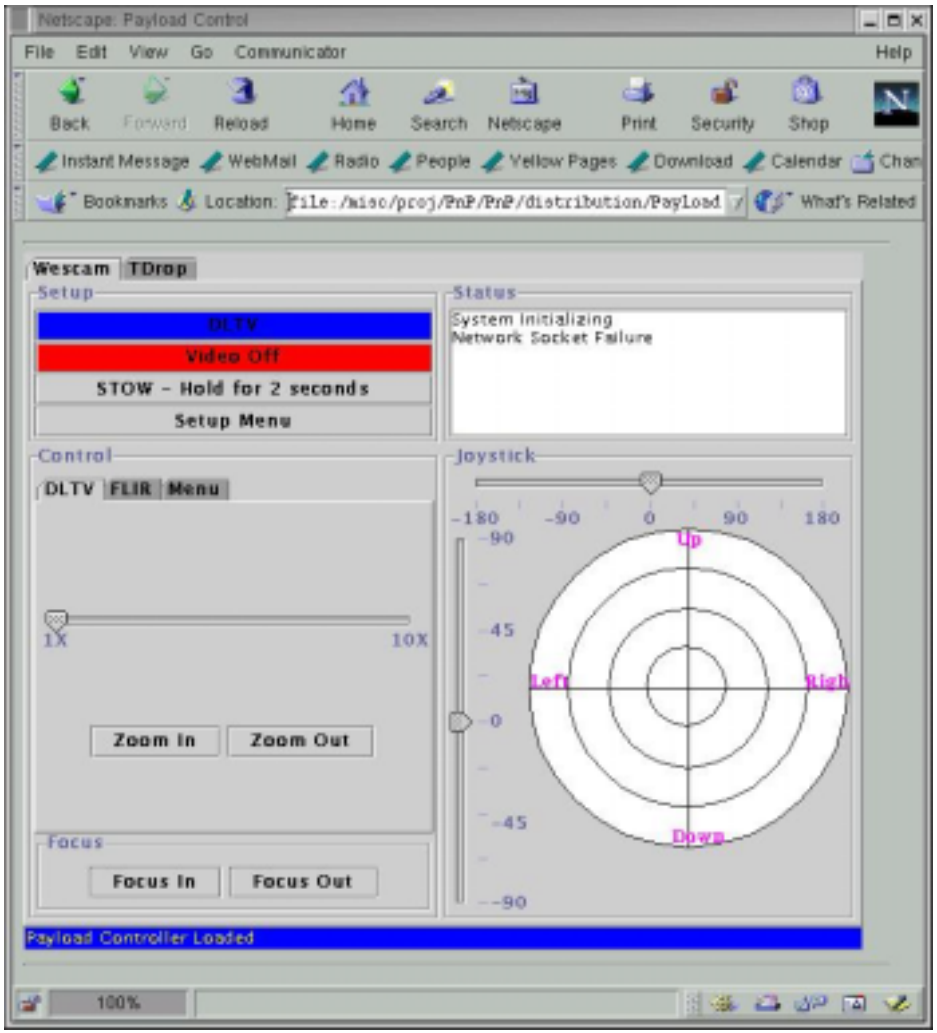
Represents a processes

Each process which communicates with the client machine communicates via a unique Port. Numbers shown are representations only.
A .jar file is a Java Archive File, which essentially is a Java Program.

Patent Pending
NSWC Crane 1/31/02

Java Panels
Wescam 12DS

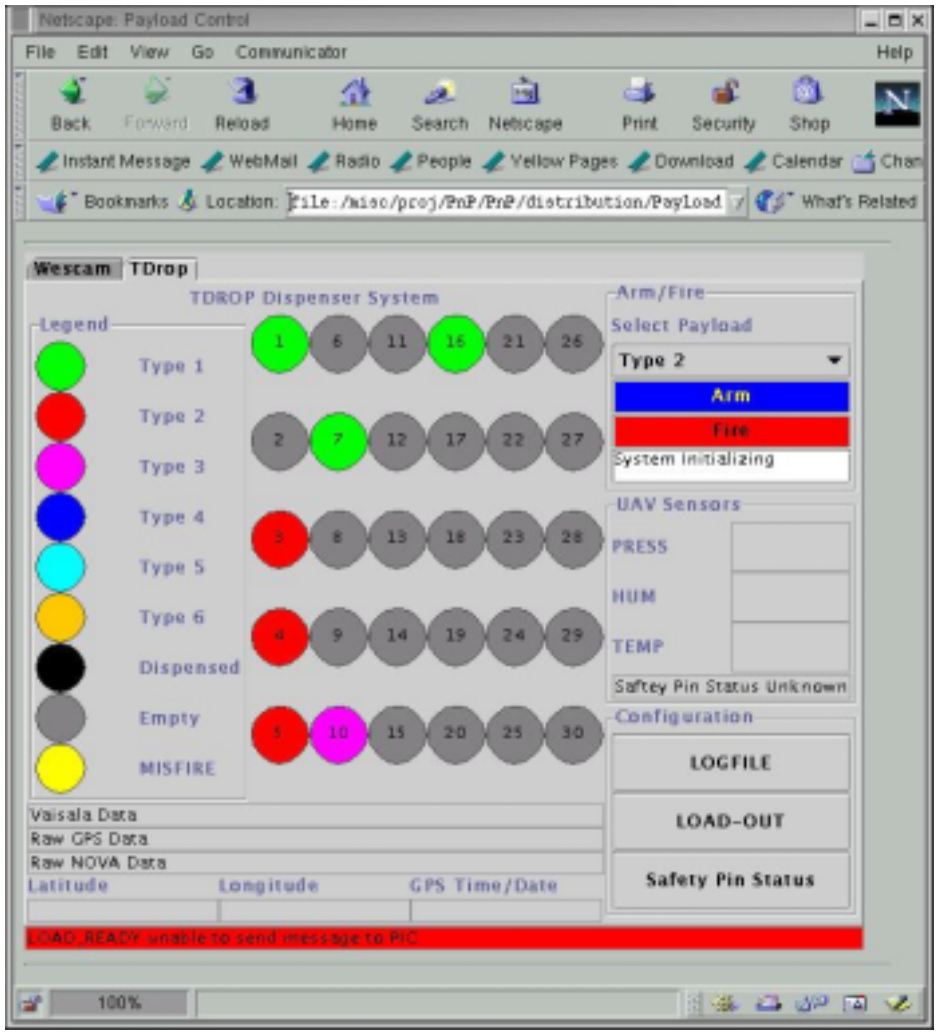
- Capable of FLIR, TV and Menu Modes
- Virtual Joystick
- Camera Controls
  - Zoom, Focus, FOV
- Menu Controls
  - Cursor, Select
- Status Messages



Patent Pending

Java Panels
TDROP

- View Loadout
  - By Cartridge Type
  - Fired, Available
- Select/Arm/Fire
- Dispenser Status
- TDROP Sensor Data
- Load Configuration



Patent Pending

Ground Station (Client)

Hardware & Software

- Standard AMD Athlon 1200 MHz PC
- MPEG-2 Decoder Card
  - Sigma Designs NetStream 2000
- Linux Operating System
  - RedHat Linux 7.1, Netscape 4.7, NetStream Drivers, Java Runtime Environment
- Windows Operating System
  - Windows 98, Netscape 4.7, Internet Explorer 5, Java 2 Runtime Environment, StreamRider 3.5

Patent Pending

The Demonstration

AUVSI Air Demonstration, 30 July 2001

30 January, 2002

Demonstration Specifics

- NAS Webster Field, MD, 30 July 2001
- Demonstrating 2 Payloads
  - Pioneer's Wescam Model 12DS EO/IR Sensor
  - T-Drop Dispenser/ Sensor/ Receiver
- Evaluate:
  - Human Factors Study
  - Feasibility
  - Limitations
  - Challenges

Demonstration Layout

Payload Interface Controller (PIC)

RS-422 Bus

RS-170

RS-232

Legacy Payloads

BAE Systems T-Drop

Neptune Sciences Dispenser

Wescam Model 12DS

Payload Control

Ethernet

TCDL ADT

RF Simulation Cable

TCDL GDT

Payload Control

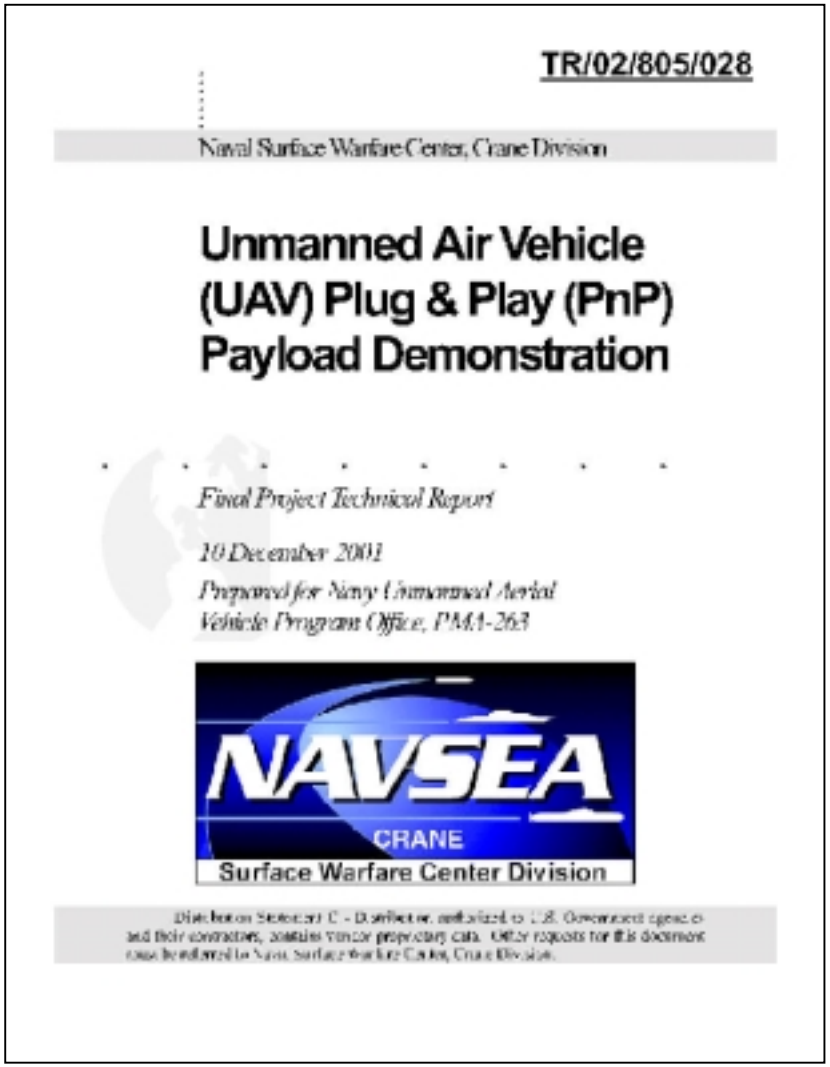
Ethernet

Computer/ Client

Patent Pending

Results

- It Works!!!
- Controlled 2 Payloads Simultaneously
- PIC Is Plug & Play
- Streaming MPEG-2 TS Video With <.5 Sec Latency
- Still Room for Growth and Improvement
  - Metadata in MPEG Stream
  - Target Location Calculations



TR/02/805/028

Naval Surface Warfare Center, Crane Division

Unmanned Air Vehicle (UAV) Plug & Play (PnP) Payload Demonstration

Final Project Technical Report

10 December 2001

Prepared for Navy Unmanned Aerial Vehicle Program Office, PMA-263

NAVSEA CRANE Surface Warfare Center Division

Lessons Learned

- MPEG-2 TS Is Not Your Standard Video
  - Very Limited on Vendors for NRT MPEG-2 TS
  - NRT Streaming Via UDP/IP Was a First
  - Decoding Stream in NRT Is Not Possible With Software Solution - Too Processor Intensive
  - Linux Client Much Faster Than Windows
- Latency Via Ethernet Is Acceptable
- Still a Lot of Work to Do
  - Different Serial Protocols, Payload Data Processing, Flight Testing, Etc.

Possible Follow-on Efforts

- Autonomous Operations FNC
  - Demonstration Testbed
- NIMA MIPO
  - Refine MPEG-2 TS Driver
  - Experimentation with KLV Metadata
- Discussions with Service UV Programs
- Non Unmanned Vehicle Applications
  - Force Protection / Remote Sensors
  - Manned Platform Sensor Integration

NAVAIR

Questions????

NAVSEA
CRANE
Surface Warfare Center Division

30 January, 2002