Raytheon

Customer Success Is Our Mission

Enterprise Service Bus for Ground Systems Integration

Raytheon Intelligence and Information Systems

G Todd Kaiser
Chief Architect, Government Systems
303-344-6915
gtkaiser@raytheon.com

March 1, 2005

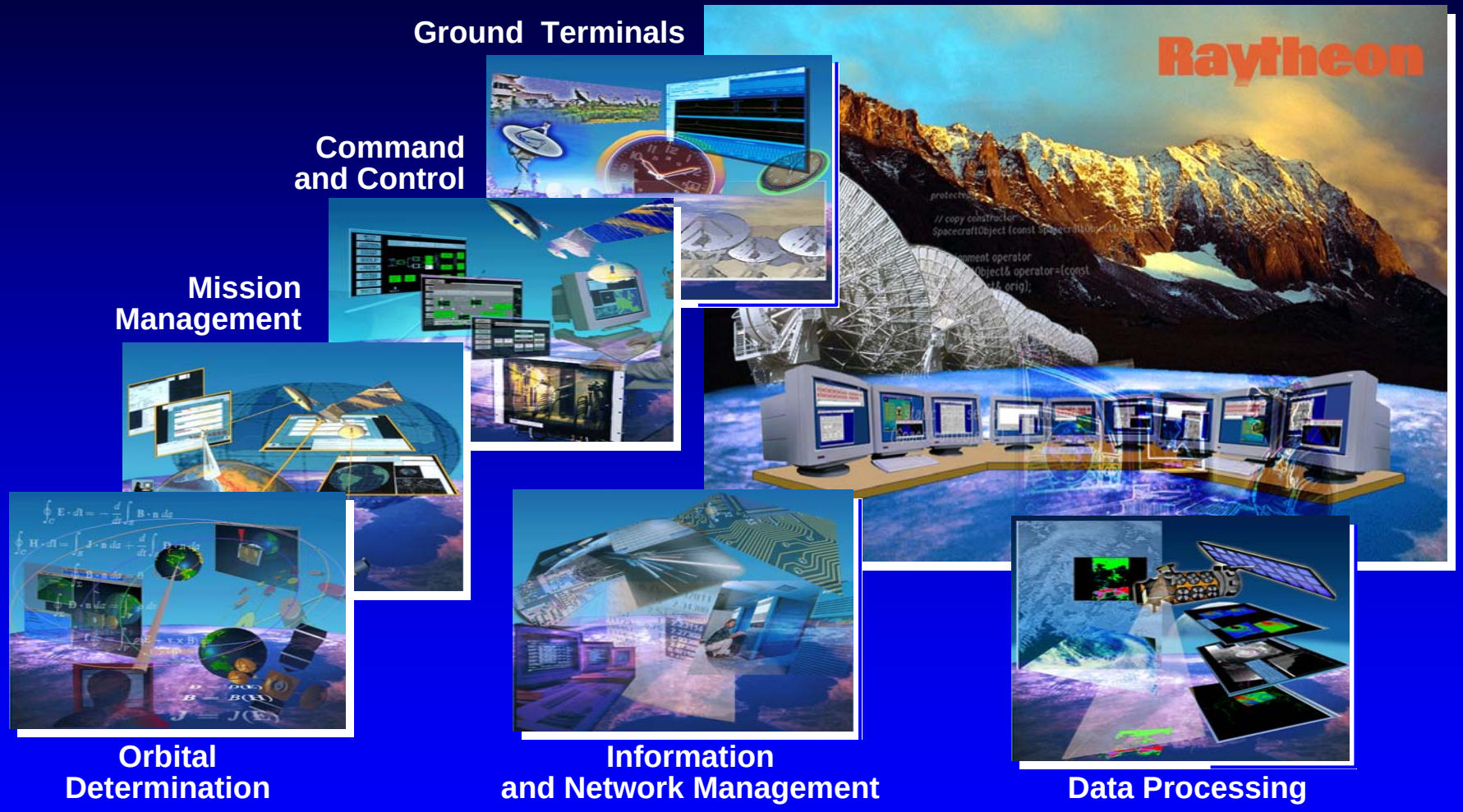
Agenda

Raytheon
Intelligence and
Information Systems

- Introduction to Raytheon Aurora
- Current Industry Environment/Challenges
- Approaches & Technologies
- SOA/ESB Overview
- Migrating An Existing Telemetry System to an ESB
- The “Bigger” Picture
- Conclusions

Raytheon Space Systems - Aurora

Raytheon
Intelligence and
Information Systems

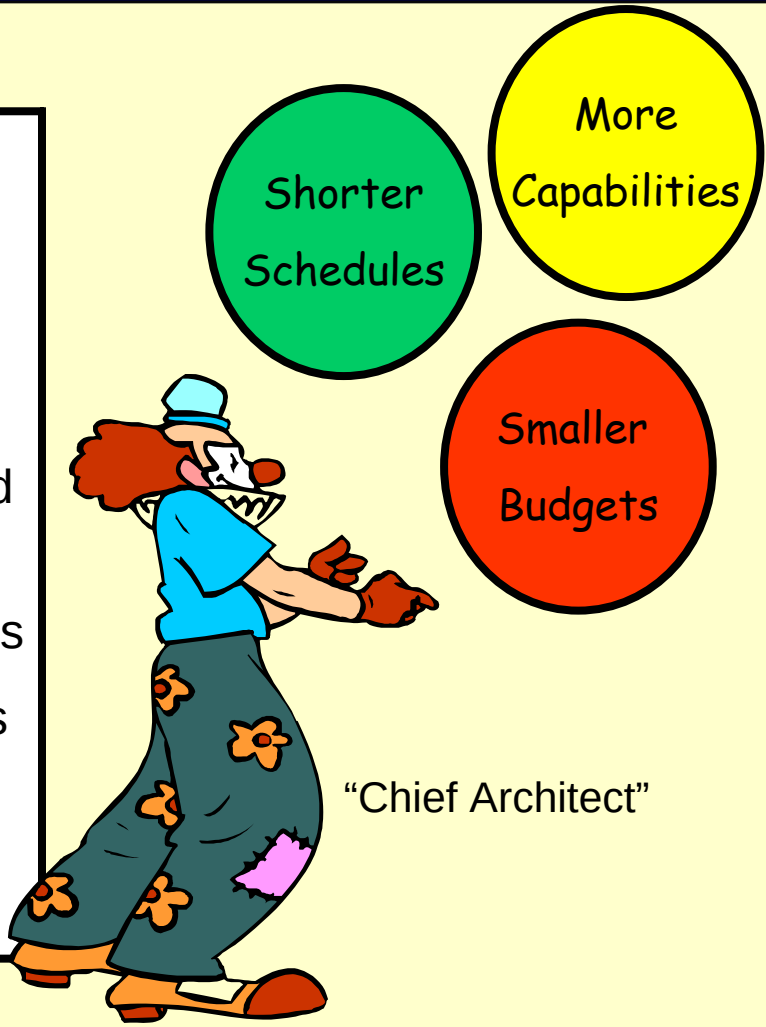


Environment & Challenges

Raytheon
Intelligence and Information Systems

Industry Environment

- Various ground architectures
- Old and new technologies
- Multiple contractors with various products
- Redundant assets through stove-piped acquisitions
- Disparate products from single vendors
- New capabilities needed by customers "yesterday"
- Systems increasing in size and complexity



Challenges

Answering The Challenge

Raytheon
Intelligence and
Information Systems

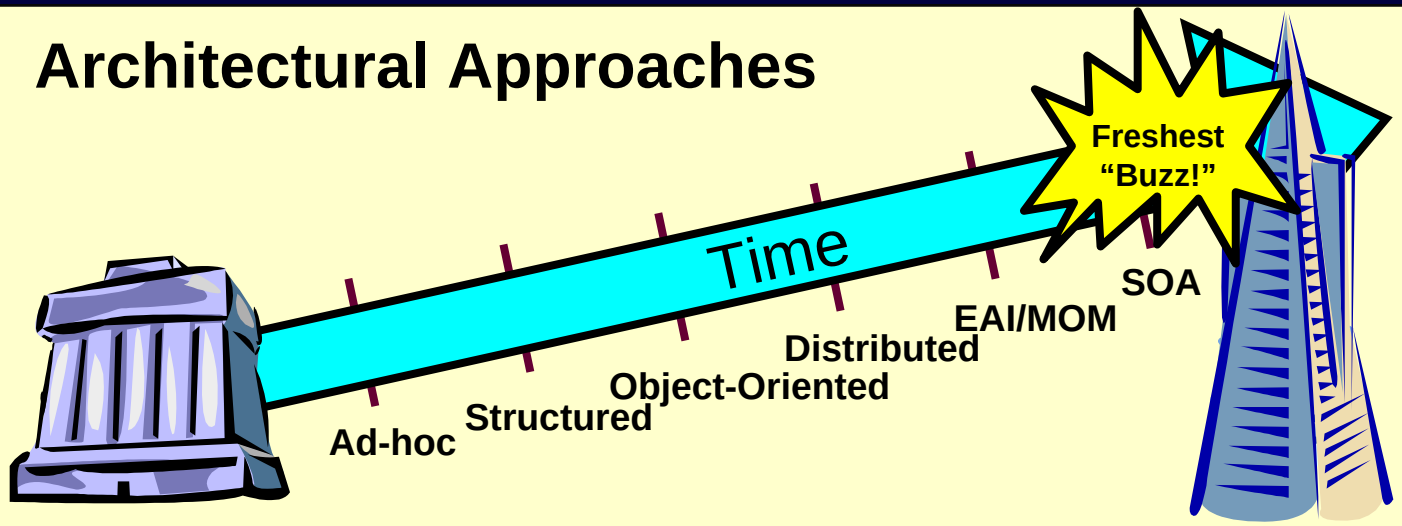
How do we tackle this?

We need an approach that includes standards, processes, and technologies used to ***leverage*** existing assets quickly, while still upholding quality and providing value.

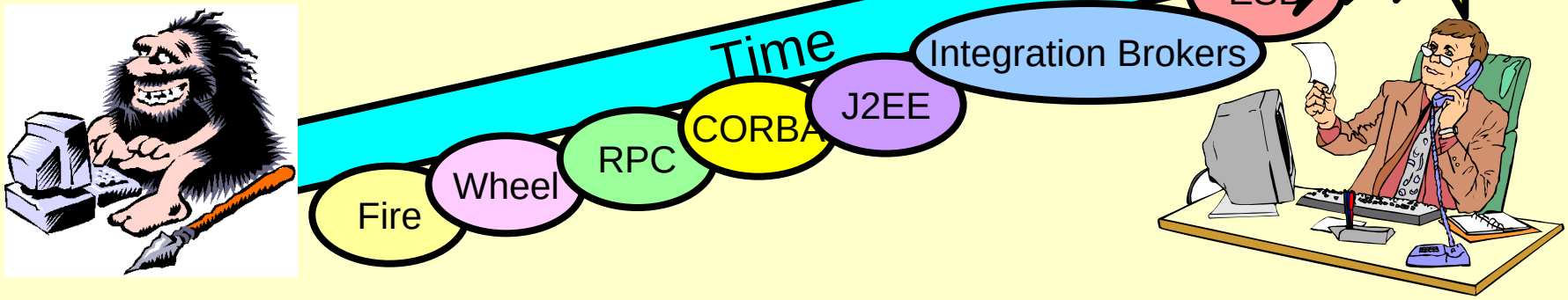
Approaches & Technologies

Raytheon
Intelligence and Information Systems

Architectural Approaches



Corresponding Technologies



Service-Oriented Architecture (SOA)

Raytheon
Intelligence and Information Systems

Goals

- Align information systems with mission goals
- Provide agile infrastructure that can change quickly as mission requirements change
- Provide a graceful (and self-paced) evolution for legacy systems

Key Aspects

- Services, NOT functions
- Separation of the interface from the implementation
- Business logic moved from the applications to the middle tier
- Services are published and discoverable

Example: NOAA's National Digital Forecast Database

Enterprise Service Bus

Raytheon
Intelligence and
Information Systems

Key Characteristics

- Transformation of data between different formats
- Messaging (usually through JMS, though not exclusively)
- Intelligent Routing
- Work-flow management (a.k.a., orchestration)
- Common data model
- Data synchronization

Integration Capabilities

- Standards-based
- Container-based service management
- Existing adaptors for legacy systems (CORBA, JMS, .NET, J2EE, etc.)
- On-the-fly data routing changes through work-flow management
- Transformation of data allows for integration of legacy services

Current Industry Best-Practice for Implementing an SOA

Migrating to an SOA with an ESB

Raytheon
Intelligence and Information Systems

To Do List:

1. **Determine Core Services**
2. **Build Higher Level Services**
3. **Model Business Processes using Services**

Core services are atomic – they don't depend on other services

Higher level services are composed of core services and are published to service directories

Business processes are realized using the new services

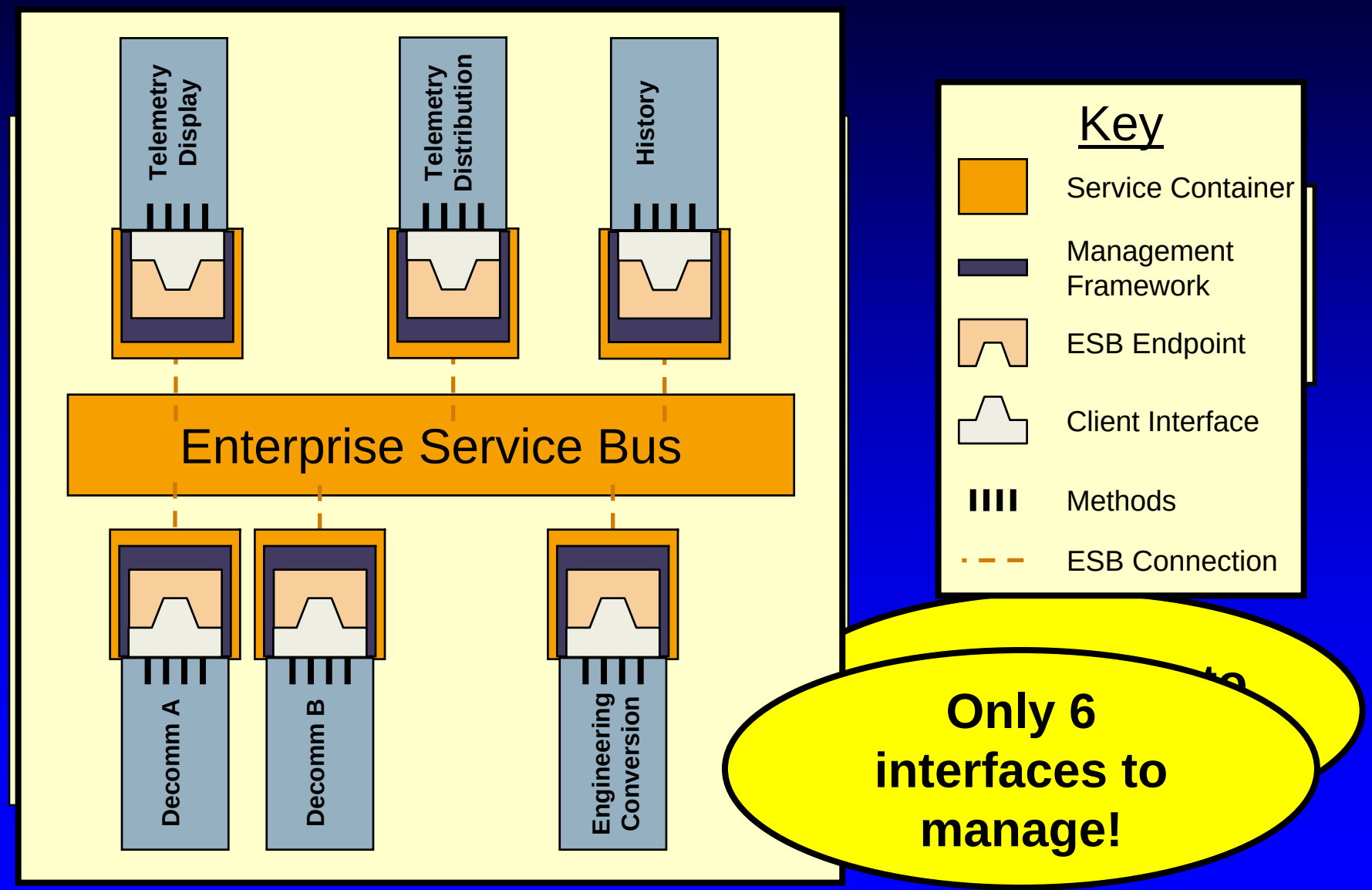
A New Way Forward

Raytheon
Intelligence and
Information Systems

- Transform existing assets into SOA *services*
  - Allows for reuse of existing investments
  - Provides SLAs that will allow aging technologies to be phased out on customer's schedules and budgets
- Center new system design on SOAs with SLAs
  - System engineering starts building SLAs, not ICDs and IRSs, and thinks in terms of capabilities and benefits, not functions and features
  - Allows separate contractors to reuse their intellectual property in order to deliver a *service* to customers
- Use Enterprise Service Bus as integration technology
  - Characteristics of ESB allow for self-paced evolution of existing systems
  - Also allows rapid (and cheaper) reconfiguration of systems to meet changing mission needs
  - Standards-based integration technologies allow for greater collaboration amongst teammates – allowing systems to scale better through "divide-and-conquer" approach

Migrate An Existing Telemetry System….. An Example Based On An ESB!

Raytheon
Intelligence and Information Systems



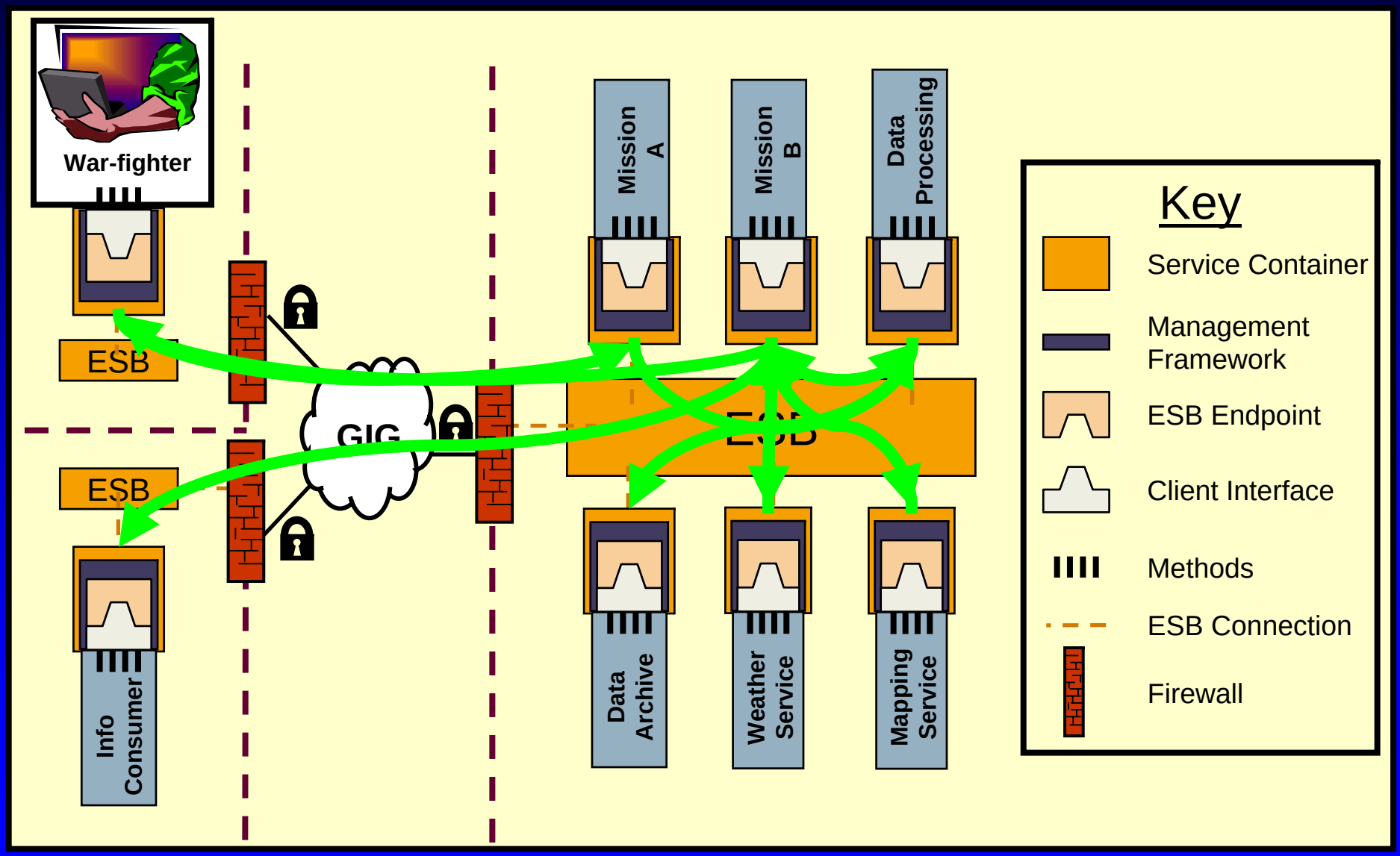
The “Bigger” Picture

Raytheon
Intelligence and
Information Systems

- Going beyond applications – integrate the entire enterprise
  - The puzzle is recursive – applications, missions, enterprises
  - Mission Planning, flight dynamics, telemetry analysis, factory test & support, mission users
- Mission-to-mission integration
  - Allow independently acquired and managed missions to collaborate by integrating them with ESB technology (standards-based, etc.)
  - Develop Service Level Agreements for each mission, NOT ICDs or IRSs
  - ESBs allow for security integration, geographically separated mission stations
  - Asynchronous messaging allows for messaging in transient environments such as the battlespace, air/space platforms, etc.

Mission-Mission Integration

Raytheon
Intelligence and
Information Systems



Conclusions

Raytheon
Intelligence and
Information Systems

- The keys to making a service-oriented architecture work are as follows:
  - Change the mindset from traditional systems engineering of ICDs/IRSs to service level agreements.
  - Pick the right services – come up with a list of key characteristics for what defines a service and judge each possible service by this criteria.
  - Determine the granularity of a service for the given problem. Some services might be too fine-grained for some problem spaces.
  - Understand the limitations of the technologies. An ESB will not solve world hunger, but it should make getting to a solution easier
- Standards, standards, standards
  - Community should start to standardize on data formats for messaging in a SOA-like architecture (e.g., a standard XML-based telemetry format)

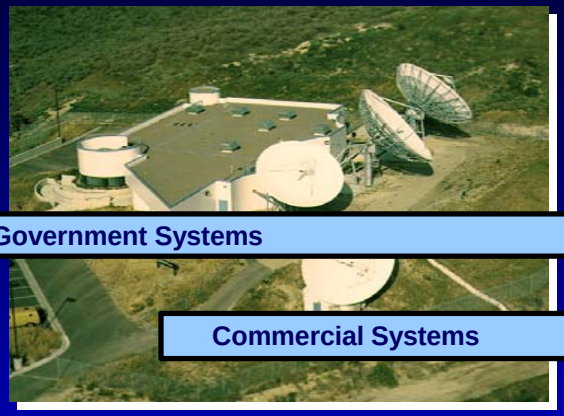
Raytheon

Customer Success Is Our Mission

Backup Slides

Raytheon Aurora Delivered Ground Systems

Raytheon
Intelligence and Information Systems



Government Systems

Commercial Systems

Common Ground Systems

- Hughes Communications Galaxy USA
- AT&T - USA
- BrasilSat COCC Brazil
- Morelos 1 Mexico
- Solaridad Mexico
- Bsky - B UK
- OPTUS Australia
- Palapa B (Telkom) Indonesia
- Palapa C (Permutel) Indonesia

- THOR 1
- Norway, Finland, and England
- MEASAT 1
- Malaysia
- Sirius 1
- Sweden
- ASIASAT 1
- Hong Kong
- Astra
- Luxembourg
- APSTAR
- China
- BrasilSat B3
- Brazil
- MEASAT 2
- Malaysia
- THAICOM
- Thailand

- CHINASAT China
- JCSAT 4 & 5 Japan
- Superbird - C Japan
- Morelos 3 Mexico
- BSAT Japan
- THOR 2 Norway
- DCCS
- CCT
- Polar EHF

- Sirlus 3 Sweden
- THOR 3 Norway
- PANAMSAT 5 US
- ASIASAT China
- Palapa Indonesia
- Orion Hawaii, Korea, and US
- AFSCN
- TDRSS

- ICO - USA
- ICO - Australia
- ICO - India
- ICO - Chile
- ICO - South Africa
- ICO - Germany
- ICO SCC - UK
- Bonum I Russia
- Thuraya UAE
- Superbird 4 Japan
- MCP
- STE

- Several Classified Systems

Migrating A Telemetry Subsystem

Raytheon
Intelligence and Information Systems

- Goal: Single, integrated ground system for various missions
  - Common API for services
- Telemetry
  - De-commutation of telemetry IS unique
  - Historical telemetry storage and retrieval IS NOT unique
  - Display of telemetry IS NOT unique
- Step 1: Core Services
  - Provide de-commutation service for each telemetry format
  - Provide a single telemetry display service (HMI integrated onto the ESB)
  - Provide a single history storage and retrieval service (tricky here – all one service or separate for real-time and off-line telemetry?)
  - Derived service: Telemetry distribution service
  - Develop a mission "agnostic" data format for telemetry – format accommodates all missions, but is not mission specific

Understand the capabilities required! Don't expose services that are not needed!

Telemetry Subsystem (cont)

Raytheon
Intelligence and
Information Systems

- Step 2: Higher-level services
  - Combine telemetry de-commutation, telemetry distribution, HMI, telemetry history into “real-time” telemetry service
- Step 3: Business Process Creation
  - Use intelligent message routing to route raw telemetry messages to correct de-commutation engine (messages tagged at source)
  - Use transformation services to transform raw telemetry formats into correct format for each de-commutation engine