



DATANET
SYSTEMS
COMMUNICATION
SOLUTIONS

believe in more

Next Generation ATC Networks Challenges & Solutions

DATANET SYSTEMS 2010

AGENDA

Air Traffic Control Environment

Air Traffic Control

General Services Structure

- **Control Services**
- **Navigation Services**
- **Aeronautical Telecommunication (AFTN) Services**
- **Meteorological Information Services**
- **Aeronautical Information Services**
- **Search and Rescue Services**



Infrastructure support for Air Traffic Services

Areas covered – voice & data

Communication (radio A/G voice, G/G voice, AFTN and G/G data communication)

Navigation (NDB, VOR, DME, ILS, MLS,..)

Surveillance (RADAR, Multilateration, ADS)

Data Processing (FDP, OLDI)



Air Traffic Control

General Control – Services concentration

Tower Control – voice services (to approach), radar information (approach), AFTN, FDP, meteo information

Approach Control - instrumental/RADAR services (approach & en Route), A/G and G/G voice services, AFTN, FDP, meteo information, etc.

En Route (Area) Control - instrumental/RADAR services (en Route), A/G and G/G voice services, AFTN, FDP, meteo information, etc.



Safety objectives

Main concern communication services “availability”

- Services should be available – maybe one of the most critical demand across industry;
- failures should be tolerated at all architectural levels:
 - card level;
 - equipment level;
 - link level;
 - node level;
 - service level;
- Multiple failures can be taken into account and solved by design;
- switching process design (main/backup) should be taken into consideration (automatic/manual)



Safety objectives (continued)

Important objective “security” of communication services

Major concern when discussing about IP environments

- services should be protected and legitimate;
- infrastructure should be able to protect the services;
- infrastructure **should** be able to detect, alarm and react to threats;
- infrastructure **should** be able to ensure (for transported information) confidentiality and integrity;
- ability to communicate/exchange information only with legitimate “external” peers;



Actual solution - Legacy

Managing different communication systems or even different infrastructures for each type of ATC specific application.

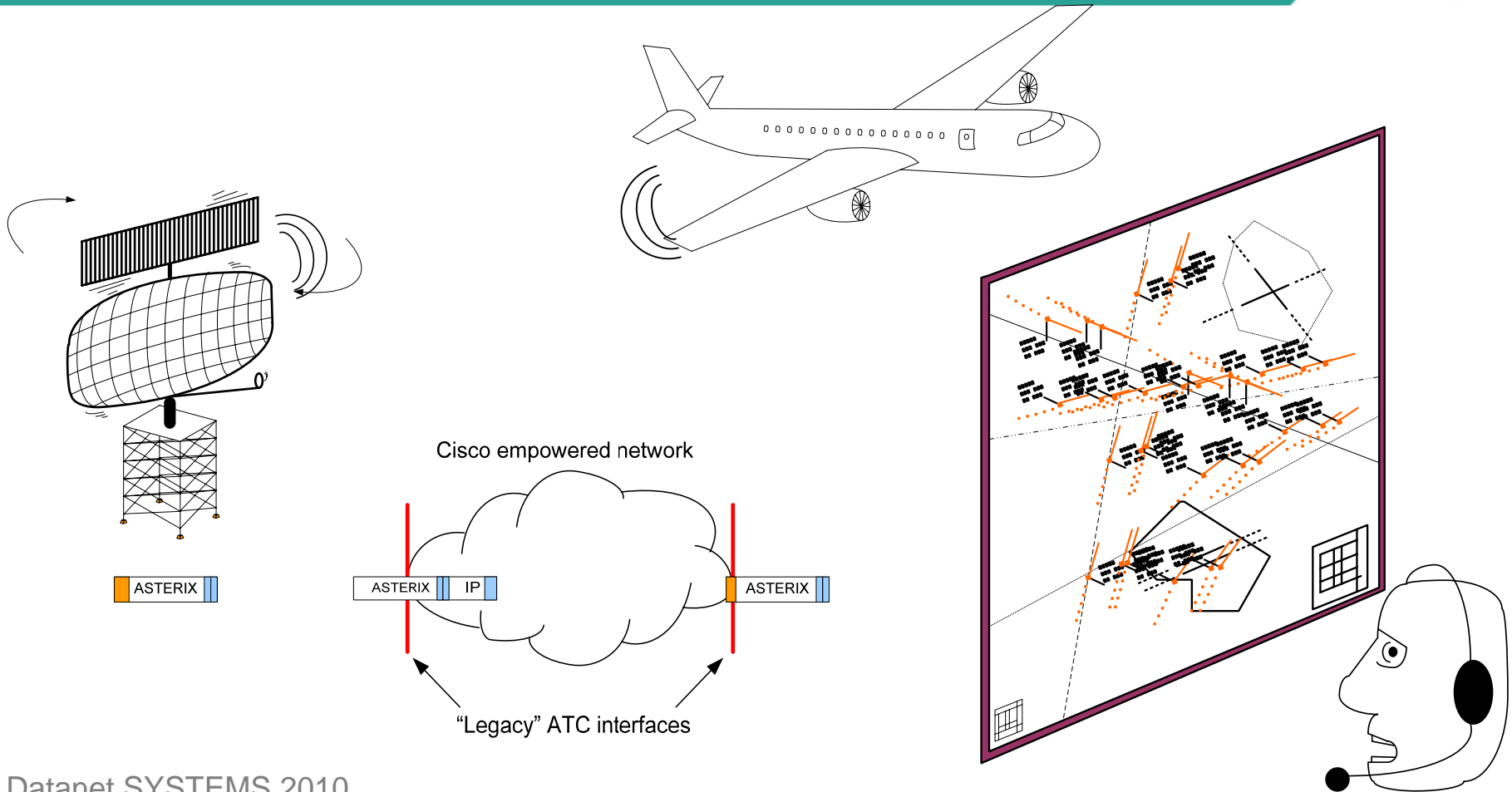
Using TDM as the preferred multiplexing technique in most time for delay sensitive applications.

Using X25 service providers (**if still available on the market**) for X25 based applications.

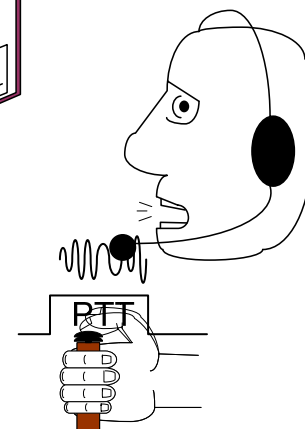
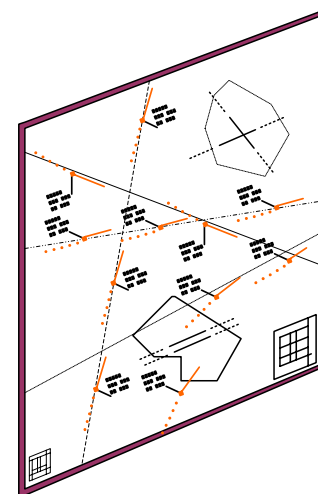
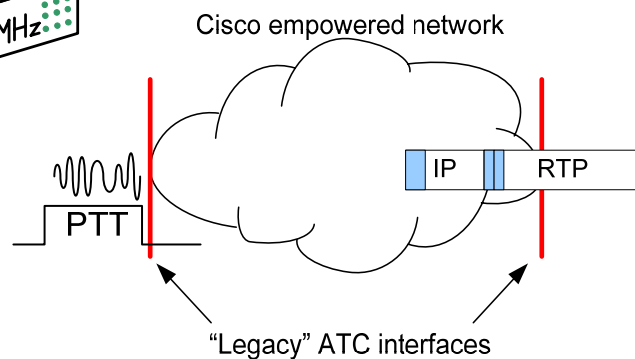
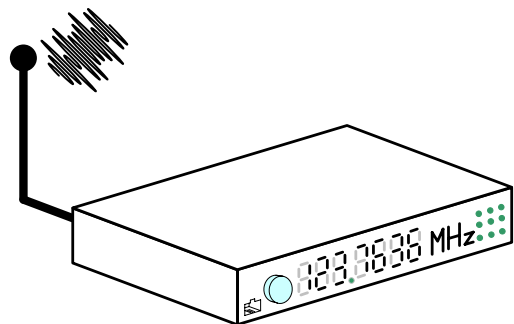
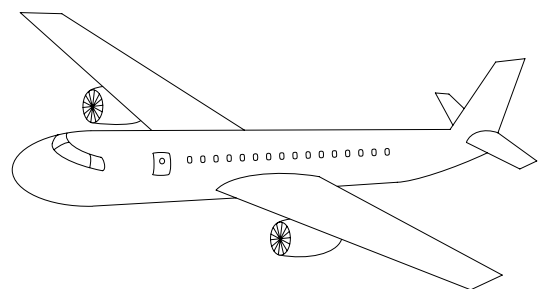
Resulting in very high costs for a very conservative industry.



ATC Specifics - Radar Data Information



ATC Specifics – Radio VHF Infrastructure



ATC Challenges - Review

- Multiple applications combining voice and data services;
- Many (legacy) protocols needed to ensure transport/compatibility (X.25, HDLC, etc...);
- Accommodate industry specific protocols (e.g. MFC-R2-ATS);
- Multiple interface types according to communication services availability;
- Accommodate voice radio infrastructure;
- Met all safety objectives;

While... :

- Offering IP based infrastructure to accommodate new ATC applications (IPv4 and IPv6);
- Ensure more simple and standardized interfaces to join neighboring networks;
- Offer proven transport solutions for existing services technology migration (e.g, IP based VHF stations)
- Lowering costs.

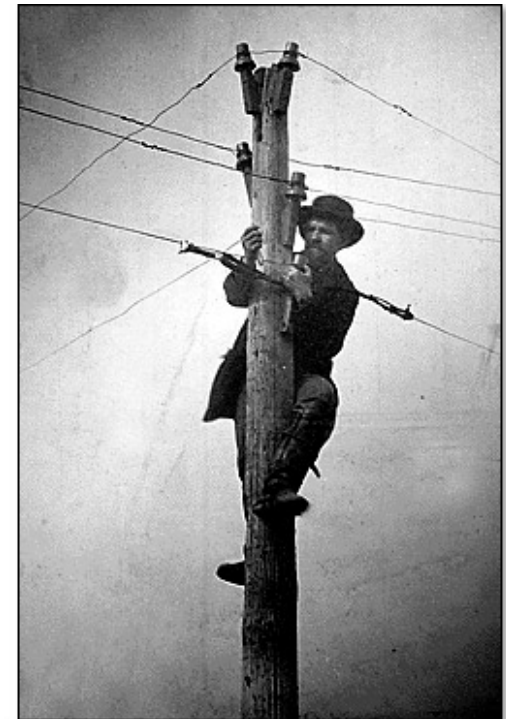
AGENDA

Air Traffic Control Communications

Doing it safely

Communication infrastructure

- Taking into account the most restrictive safety objective – VHF A/G voice comm. – the availability requirement for end-to-end communication system must be better than **99,99984%**.
- This translates into an overall availability requirement for the IP communication system of at least **99,999975%**.
- Include security features to protect both services and infrastructure
 - ability to detect threats;
 - ability to react;
 - accommodate real time and non real time applications and ensure differentiation
 - able to ensure separation between administratively separate entities



NATIONAL ARCHIVES

Doing it open to evolution

The islands need to be connected

Unique integrated infrastructure

Split functionality - highly redundant design, able to adapt to failures in seconds and below, on geographically dispersed areas, including gateway failure

Able to be easily extended (geographical coverage and capacity)

Open architecture able to evolve as the communication needs to evolve

IPv6 enabled–aeronautical standards (e.g. AMHS, Radar distribution)



Doing it compatible

Traditional TDM based services compatibility until migration to IP:

- voice Ground-Ground & Air-Ground
- special data transfers for aeronautical applications

Ensure compatibility for PtoP leased lines until new point-to-multipoint IP enabled services become available and thus...

Achieving a resilient Multicast-Ready infrastructure – needed for data distribution (e.g. weather, radar etc...)



But still...

One network!!!

One solution, if possible...



AGENDA

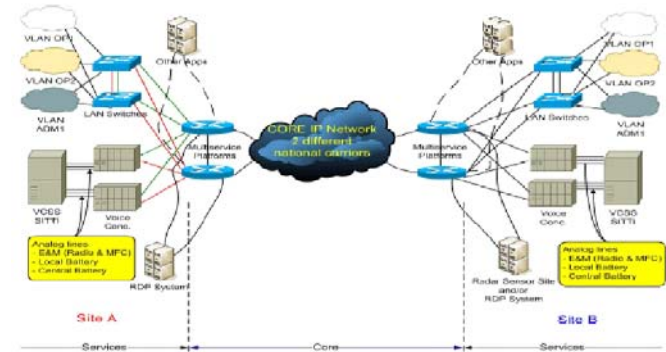
Air Traffic Control

Datanet CISCO based solution

The ALL in ONE Redundant Network

Based on IP technology

- Layered architecture
 - Core
 - Access
- Ensures separation:
 - Different features activated on different equipment
 - Multiple levels of resiliency
- Multiple levels of security
 - Traffic inspection
 - VPN separation



Voice services – Legacy and more

All voice transport migrated to IP technology

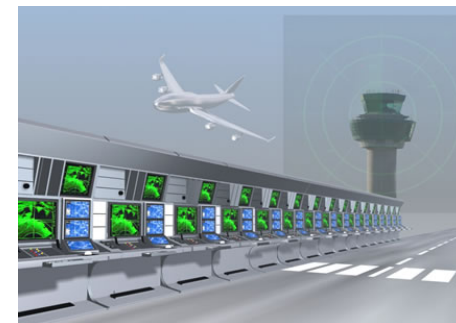
- Ground-Ground Voice services
 - CISCO Gateways – for VCSS intercom
 - Fast convergence and service restoration
 - Protection for ANY failure (including Gateways)
- Air-Ground voice (controller to aircraft communication):
 - CISCO Gateways
 - PTT transport ensured by CISCO solution
- Administrative voice
 - CISCO Call Manager based solution
 - Tower communication covered also
 - CCM redundancy implemented



RADAR Data Dissemination

Adapting IP technology to support:

- Traditional synchronous bit stream technology
 - Converted on emulated point-to-point lines over IP technology highly sensitive to delay variation
 - Transport ensured from Radar heads to MRT devices
 - Redundancy ensured on any radar head through dual lines deployment (no common path)
- Native IP Radar data
 - IP Multicast based dissemination
 - Multiple levels of resiliency (path, RP etc...)
 - Tested also for IPv6
 - Infrastructure working
- As other particular solutions...



Native IP based Communications

Data services operational & administrative

Special requirements

- For guaranteed QOS
- For guaranteed bandwidth
- For traffic separation into separate domains (VPN)
 - Administrative area
 - Operational area
 - External services areas

WAN transport

- Encryption required for all IP based WAN transport services
- Multiple paths for the IP traffic (at least 3)
- Ready for IPv6



Safety objectives solution

Important objective “availability” of communication services

A/G voice communication **maximum interruption time** = 4 sec. (for an end to end circuit including the TDM part)

G/G voice communication **maximum interruption time** = 4 sec.

Voice communication **maximum interruption time** = less than 500 msec. (for a failure in the IP infrastructure)

G/G data communication (flight plans exchange, RADAR data exchange, etc.): **maximum interruption time** = below sec.

For all type of service the outages occurrence should be less frequent than 1/month.

Ability to accommodate **disaster scenarios** by only network reconfiguration – no dual networks in place!



Safety through security

Ensure “security” of communication services

Edge deployment of security devices:

- Firewalls
- IDS/IPS systems
- Intelligent use of IOS features of routers and switches;
- Use encryption at Wide area level;
- Use encryption & authentication to exchange information with peers (routing);
- MPLS VPN used widely to separate services;
- Control access to resources and infrastructure



CISCO Catalyst 7600 series

High performance completely redundant **Core Layer**

Up to 720 Gbps in a single chassis, or 40 Gbps capacity per slot

Broad level of services in same chassis

High-performance IP/MPLS features

Broad set of available Low- and High-Speed Interfaces ranging from T1/E1 up to 10GE/OC192

The key focus areas for the Cisco 7600 Series are:

- Carrier Ethernet & Quad-Play
- Mobile Architectures
- Public Sector & Enterprise



CISCO Catalyst 7600 series

Review of features used for **Core Layer**

MPLS deployed for VPN

cRTP used for VoIP (in parallel)

ISIS for fast convergence

BFD for fast failure detection

CBWFQ & LLQ for QOS

Multilink used for slow speed WAN links

FR used for some WAN links

E1 and Serial Synchronous to GE ports on one box



CISCO Catalyst 7600 Series Security

Firewalls and IDS/IPS – Protecting the **Core Layer**

FWSM delivers strong application-layer security.

Intelligent, application-aware inspection engines that examine network flows at Layers 4 to 7.

FWSM tracks the state of all network communications and prevents unauthorized network access.

IDS/IPS protects each VRF (VPN) instance from the external world in each interconnection point.

IDS/IPS can scale to up to 8 modules per chassis, up to 4 Gbps of inline prevention.



CISCO ISR 3800/3900 series

The multiservice platform for **Access Layer**

- IOS and hardware features as **XoT, STUN, L2TPv3, CEM, DSP, VoIP** harmonizing apparently antagonist services
- ISRs optimized for secure, wire-speed delivery of concurrent data, voice, video, and wireless services
- 3800 Series routers deliver multiple concurrent services up to wire-speed T3/E3 rates
- 3800 Series transparently integrates advanced technologies, adaptive services, and secure enterprise communications
- 3800 Series routers also feature the widest range of voice-gateway interfaces
- Actually validating 2900 and 3900 ISR G2 CISCO Series



CISCO ISR 3800/3900 series

Review of key features used for **Access Layer**

- IOS X25-XoT features for X25 native applications still in use like OLDI and CIDIN
- IOS L2TPv3 or STUN features for structured synchronous serial streams used in radar data dissemination
- IOS UDPTN or RAW TCP features for asynchronous serial streams
- Cisco Hardware NM-CEM for unstructured serial streams
- Third party devices as abstraction layer for nonstandard voice signaling protocols like MFC-R2-ATS
- Cisco Hardware DSP pools for A/G voice services with PTT/SQL support
- Features actually targeted/tested on ISR G2's



Datanet Management Solution

Local management for Network nodes

Ability to integrate in a single screen all deployed services:

- router health including environmental parameters;
- Visual & auditive alarms;
- Wide Area Communication interfaces status;
- Traffic and error level;
- Radar channel status and traffic level;
- Voice channels monitoring;
- Includes syslog server.

CL131 C	CL131 B	ACCESS# A1	ACCESS# B2	CL1-129W-A	CL1-129W-B	V4.1.30 19.11.2009	
CORE-A1	Redundancy: SSO	Slot 5 / 7	PS1 PS2	Module: 1 3 3 6 2 8 9	24°C / 31°C	FANS: OK	Last Update: 00:02:24
CORE-B2	Redundancy: SSO	Slot 6	PS1 PS2	Module: 1 3 3 6 2 8 9	24°C / 30°C	FANS: OK	Syslog Polling Freq: 15 sec

Voice Channels	Voice G/W	Uptime	Endpoint	Peer	WAN Path	CDP	Traffic (%)	Errors (%)	Overtime
APP-ARISE	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	CO2-Core-B2	RTG-CORE-A1	IN: 0.00	OUT: 0.00	00:00:11
APP-WEB01	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	CO2-Core-B2	RTG-CORE-A1	IN: 0.00	OUT: 0.00	00:00:29
APP-NAPOC	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	Arad-Core-B2	Arad-Core-A1	IN: 0.00	OUT: 0.00	00:00:16
TWR-CL13	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	Arad-Core-B2	Arad-Core-A1	IN: 0.00	OUT: 0.00	00:00:00
TWR-TECH	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	Arad-Core-B2	Arad-Core-A1	IN: 0.00	OUT: 0.00	00:00:39
PRM-CL13	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	Arad-Core-B2	Arad-Core-A1	IN: 0.00	OUT: 0.00	00:01:00
ARAD-EMERSON	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	Arad-Core-B2	Arad-Core-A1	IN: 0.00	OUT: 0.00	00:00:39
ARAD-215M	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	Arad-Core-B2	Arad-Core-A1	IN: 0.00	OUT: 0.00	00:01:00
NAPOC MAIN 1	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	Arad-Core-B2	Arad-Core-A1	IN: 0.00	OUT: 0.00	00:00:00
NEEDS TOP 2	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	Arad-Core-B2	Arad-Core-A1	IN: 0.00	OUT: 0.00	00:00:11
NAPOC TEST	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	Arad-Core-B2	Arad-Core-A1	IN: 0.00	OUT: 0.00	00:16:28
NAPOC ARAD MAIN FG	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	Arad-Core-B2	Arad-Core-A1	IN: 0.00	OUT: 0.00	00:25:00
NAPOC ARAD EMERGENCY FG	CI-CL131-D	6:00:00	10.0.0.162	RTG-CORE-A1	Arad-Core-B2	Arad-Core-A1	IN: 0.00	OUT: 0.00	00:01:30

Radar Channels	Radar G/W	Interface	Endpoint	Delta
SLD 2 -> BUJURESTI	CI-ACCESS-02	Serial1/0	10.02.16.21	00
SLD 3 -> ARAD	CI-ACCESS-02	Serial1/0	10.02.16.21	00
SLD 4 -> ARAD	CI-ACCESS-01	Serial1/0	10.02.16.21	00
SLD 5 -> BUCURESTI	CI-ACCESS-01	Serial1/0	10.02.16.21	00
SLD 6 -> BUCURESTI	CI-ACCESS-01	Serial1/0	10.02.16.21	00

Afisarea mesajelor Syslog				Timput curent : 14:05:16 29-03-2010
Numele site: CI				Update la : 11:05:09 29-03-2010
Nivelele syslog afisate : <input checked="" type="checkbox"/> Emergency <input checked="" type="checkbox"/> Alert <input checked="" type="checkbox"/> Critical <input checked="" type="checkbox"/> Error <input checked="" type="checkbox"/> Warning <input checked="" type="checkbox"/> Notice <input checked="" type="checkbox"/> Info <input checked="" type="checkbox"/> Debug				Inregistrari afisate : 20
Data de incput: Zua 29 / Luna 3 / Anul 2010 / Ora 00 : 00				Text continut : <input type="text"/>
Run query				Ultima 20 de inregistrari
Copyright © 2002				
Accesina saist ultimele 20 de mesaje (in ordinea descrescatoare):				
29-03-2010	11:03:07.681	Info	127.0.0.1	%PMCT: Nu mai exista depasire de prag la RTC-CI-CORE-A1 spre TWR TH (CI-CORE-A1,multlink68).Valoarea inregistrata este : 22.97%, iar valoarea de prag este 70%.
29-03-2010	11:03:07.681	Info	127.0.0.1	%PMCT: Nu mai exista depasire de prag la RTC-CI-CORE-A1 spre TWR SM (CI-CORE-A1,multlink67).Valoarea inregistrata este : 30.41%, iar valoarea de prag este 70%.
29-03-2010	11:03:07.681	Info	127.0.0.1	%PMCT: Nu mai exista depasire de prag la RTC-CI-CORE-A1 spre TWR SB (CI-CORE-A1,multlink69).Valoarea inregistrata este : 50.56%, iar valoarea de prag este 70%.
29-03-2010	11:03:07.681	Info	127.0.0.1	%PMCT: Nu mai exista depasire de prag la RTC-CI-CORE-A1 spre TWR BM (CI-CORE-A1,multlink66).Valoarea inregistrata este : 17.39%, iar valoarea de prag este 70%.
29-03-2010	11:02:53.320	Alert	127.0.0.1	%PMCT: Depasire de prag 2 la RTC-CI-CORE-A1 spre TWR TH (CI-CORE-A1,multlink68).Valoarea inregistrata este : 100%, iar valoarea de prag este 80%.
29-03-2010	11:02:53.320	Alert	127.0.0.1	%PMCT: Depasire de prag 2 la RTC-CI-CORE-A1 spre TWR SM (CI-CORE-A1,multlink67).Valoarea inregistrata este : 100%, iar valoarea de prag este 80%.
29-03-2010	11:02:53.320	Alert	127.0.0.1	%PMCT: Depasire de prag 2 la RTC-CI-CORE-A1 spre TWR SB (CI-CORE-A1,multlink69).Valoarea inregistrata este : 100%, iar valoarea de prag este 80%.
29-03-2010	11:02:53.320	Alert	127.0.0.1	%PMCT: Depasire de prag 2 la RTC-CI-CORE-A1 spre TWR BM (CI-CORE-A1,multlink66).Valoarea inregistrata este : 100%, iar valoarea de prag este 80%.
29-03-2010	11:02:37.897	Info	127.0.0.1	%PMCT: Nu mai exista depasire de prag la RTC-CI-CORE-A1 spre TWR TH (CI-CORE-A1,multlink68).Valoarea inregistrata este : 61.51%, iar valoarea de prag este 70%.
29-03-2010	11:02:37.897	Info	127.0.0.1	%PMCT: Nu mai exista depasire de prag la RTC-CI-CORE-A1 spre TWR SM (CI-CORE-A1,multlink67).Valoarea inregistrata este : 48.21%, iar valoarea de prag este 70%.
29-03-2010	11:02:37.897	Info	127.0.0.1	%PMCT: Nu mai exista depasire de prag la RTC-CI-CORE-A1 spre TWR SB (CI-CORE-A1,multlink69).Valoarea inregistrata este : 61.19%, iar valoarea de prag este 70%.
29-03-2010	11:02:37.897	Info	127.0.0.1	%PMCT: Nu mai exista depasire de prag la RTC-CI-CORE-A1 spre TWR BM (CI-CORE-A1,multlink66).Valoarea inregistrata este : 61.17%, iar valoarea de prag este 70%.
29-03-2010	11:02:22.495	Alert	127.0.0.1	%PMCT: Depasire de prag 2 la RTC-CI-CORE-A1 spre TWR TH (CI-CORE-A1,multlink68).Valoarea inregistrata este : 100%, iar valoarea de prag este 80%.

CONCLUSIONS

One ATC SOLUTION – Cisco IOS & hardware

IP, a **safe** technology proven by more than 6 years active operation in ATC business and more than one quarter of a century in the real harsh world.

A **reliable** solution consolidating all different ATC communication services onto the same very resilient infrastructure.

An **adaptive** solution able to quickly include all features required for future ATC trends.

Unmatched practical field experience gained into the actual implementation by Datanet SYSTEMS and CISCO Systems.





DATANET
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Thank you!

Next Generation ATC Networks
Challenges & Solutions

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