Operational

Datalink

Service

LINK 2000+

Implementation

Simulations

Washington D.C. 27 April 2000

Real Time Simulation

Main objective:

- **To determine the controller workload using data link environment.**

Simulation Environment

- **Reims, Paris and Maastricht ACCs**
- **Validated traffic samples based on 7 August 98 traffic:**
  - 3 different traffic volumes: baseline, 150%, 200%
  - 4 equippage rates for each traffic volume: 0%, 50%, 75% and 100%
- **One “measured” sector, Reims (FL245 to UNL)**
- **ESCAPE real time simulator**

Simulator Components

- Ground System: CWP, FDP, G-G coordination and surveillance, ground part of the data link services, interface to ATN
- Air System: pseudo-pilot positions, flights generator, air part of the data link services
- ATN emulation called ATN-Lite
- Delay model
- EATCHIP HMI

Data Link Services

- Data Link Initiation Capability
- ATC Clearances
- ATC Communications Management
- Controller Access Parameters

Results

Subjective feedback

ISA, questionnaries, comments, observation during execises

Objective Data

- **Recordings of:**
  - controllers verbal comms (R/T and telephone)
  - a/c profile
  - interaction of controllers with the HMI

Data Analysis

As an input for the next steps, we used ONLY the objective data, namely the reduction of R/T comms.

How did we get the the w/l reduction ? (1)

Example

Traffic Sample L2KMH0:

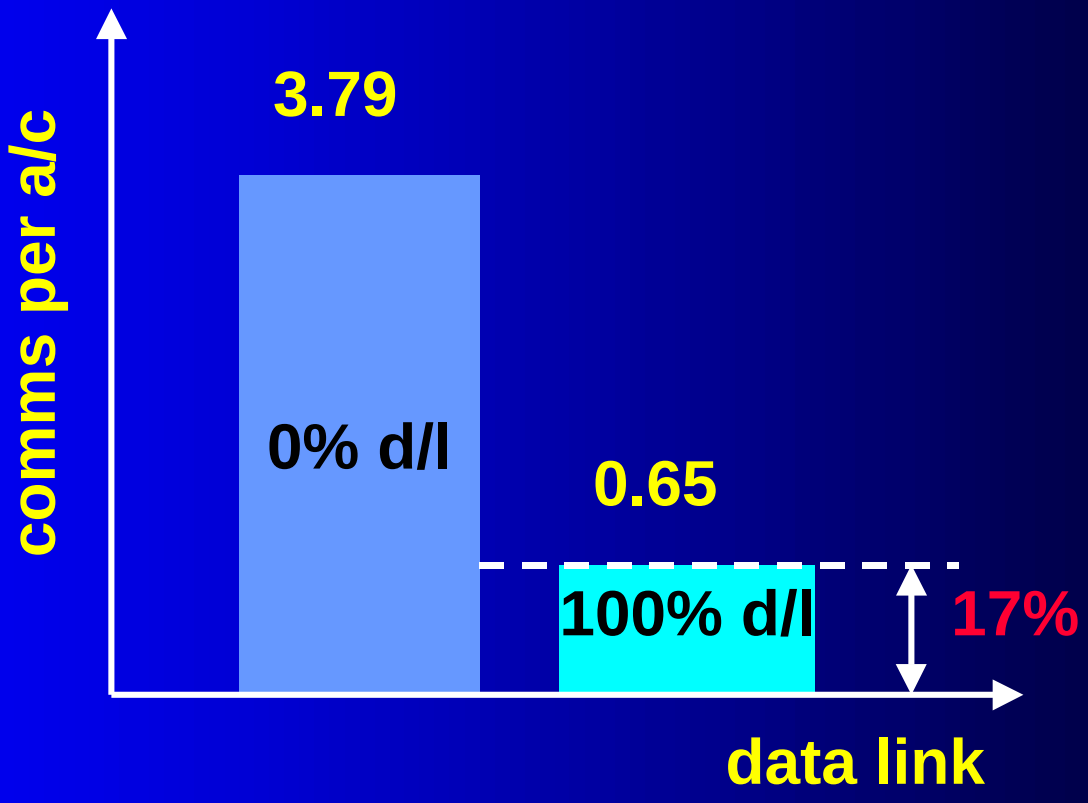
- **0% d/l**
- **High Traffic (200% more than baseline)**
- **Comms: 337**
- **No of a/c: 89**
- **Comms per a/c: 3.79**

How did we get the the w/l reduction ? (2)

Traffic Sample L2KMH1:

- **100% d/l**
- **High Traffic (200% more than baseline)**
- **Comms: 58**
- **No of a/c: 89**
- **Comms per a/c: 0.65**

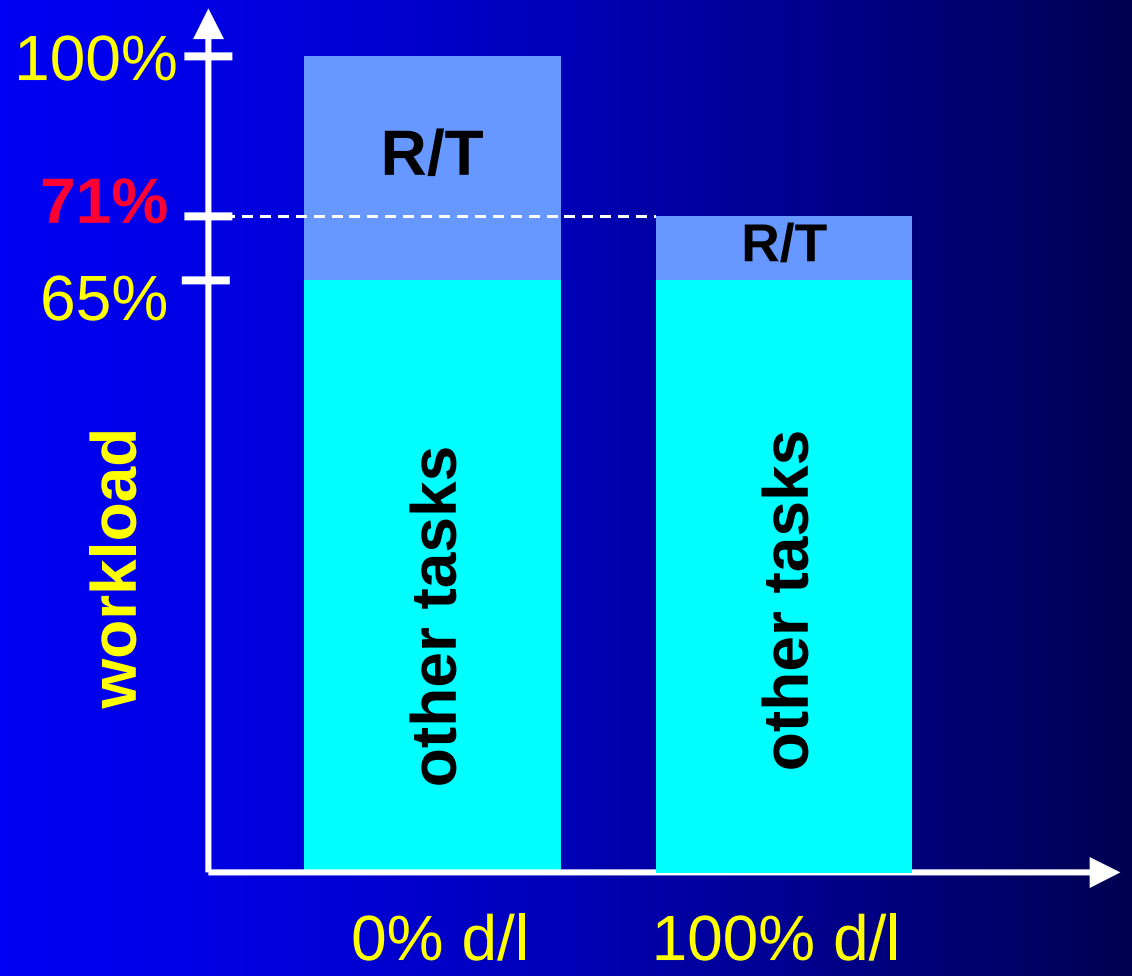
How did we get the the w/l reduction ? (3)



How did we get the the w/l reduction ? (4)

- The R/T workload is generally accepted to be 35% - 50% out of the total workload. We have chosen 35%.

How did we get the the w/l reduction ? (5)



How did we get the the w/l reduction ? (6)

It is generally accepted that the capacity increase is half of the spared workload.

Example:

- New workload is 71%
- Capacity gain is 14%

Final Results

- 50% d/l equipage - 8% capacity increase
- 75% d/l equipage - 11% capacity increase
- 100% d/l equipage - 14% capacity increase

COSAAC Simulation

Common Simulator to Assess ATFM Concepts

- Fast time simulator
- Investigate the impact of traffic and capacity growth on ATFM delays
- ATFM Delay = the duration between the last take off time requested by the a/c operator and take off slot given by CFMU
- A similar tool is working at CFMU, TACT/CASA (Tactical Database / Computer Assisted Slot Alocation)

INPUT

- Maps (airspace, beacons…)
- CFMU archived flight plans
- ATC capacities
- ATC sectors configurations

OUTPUT

- Delay reports

DATA

- Traffic sample from 16 April 1999, lower and upper traffic.
- Capacity increase as resulted from real time simulation and confirmed by CAPAN simulation:

- reference capacity (0% d/l)
- 8% more capacity (50% d/l)
- 11% more capacity (75% d/l)
- 14% more capacity (100% d/l)

Results

	Decrease of delay by:
- 8% more capacity (50% d/l)	41%
- 11% more capacity (75% d/l)	59%
- 14% more capacity (100% d/l)	66%

Weaknesses:

- **Only one traffic sample**
- **Lower and upper traffic**
- **Extrapolation of a uniform capacity increase to all sectors**

The 66%(100% d/l) figure was reduced to 50% to compensate the simulation effects.

The medium value used for the CBA was 25%.

CAPAN Simulation

ATC Capacity Analyzer

- Fast Time Simulator
- Task based model
- Main Objective:
  - Assessment of the benefits in terms of capacity increase which could be expected with the introduction of data link.

Simulation Environment

- Karlsruhe UAC is a very heavily loaded a/s with a capacity/demand ratio of 0.88 (1998)
- 14 sectors
- Traffic Sample from Friday 9th July 99 (peak day of Summer 99 with 2418 flights) which was increased by 35% to get the 2005 traffic
- 25%, 50%, 75% and 100% fleet equipage
- RVSM levels

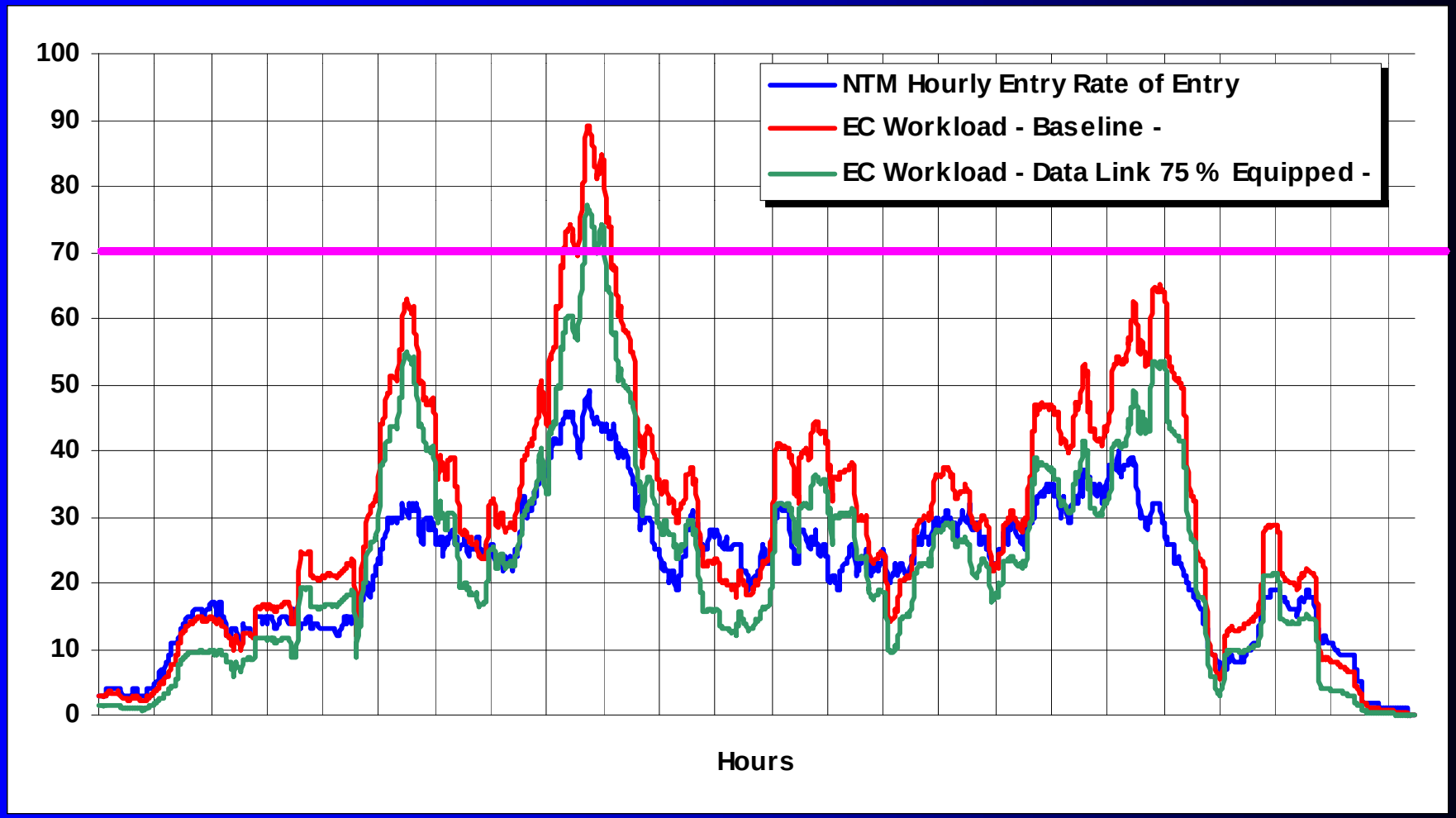
INPUT

- Task Execution Time extracted from the Real Time Simulation. Only standard R/T w/l were affected.

OUTPUT

- Workload generated by the passage of traffic in the sector
- Sector capacity

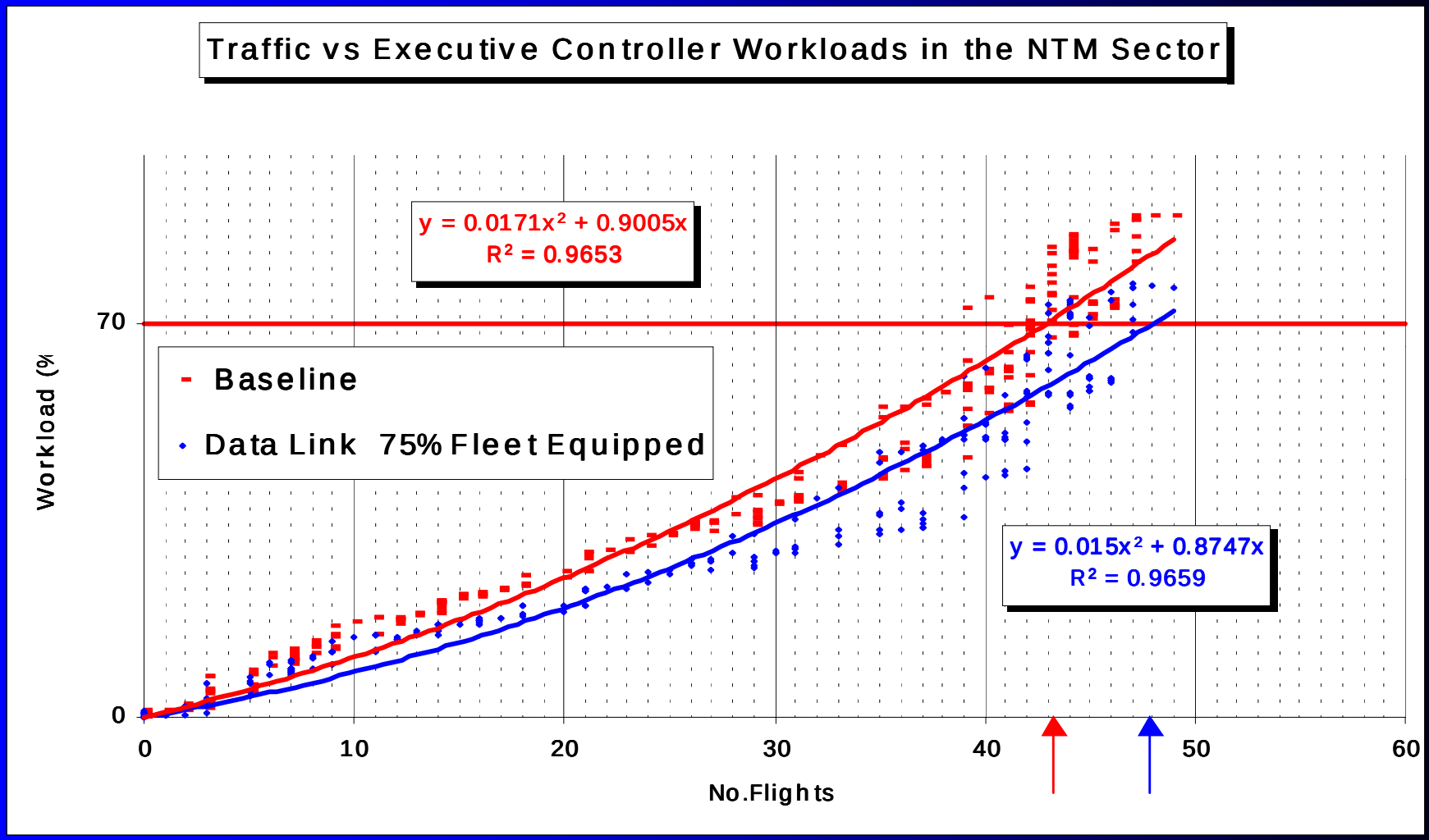
Methodology (1)



Methodology (2)

- CAPAN generated a 3 hours traffic sample encompassing the peak hour, for each sector.
- CAPAN draw the curves *Workload=f(Traffic)*
- The sector capacity is given by the intersection between these curves and the 70% threshold.

Methodology (2)

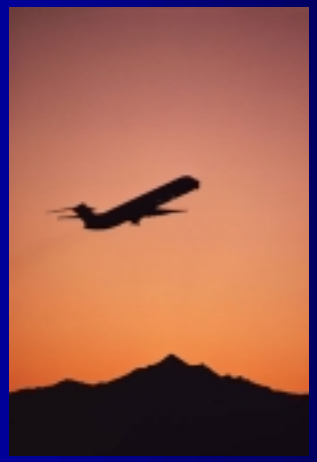


Results

	Real Time Sim
- 25% d/l capacity increase with 3.4%	
- 50% d/l capacity increase with 7.8%	*8 %*
- 75% d/l capacity increase with 11.2%	*11%*
- 100% d/l capacity increase with 15.9%	*14%*

Real-time Simulation

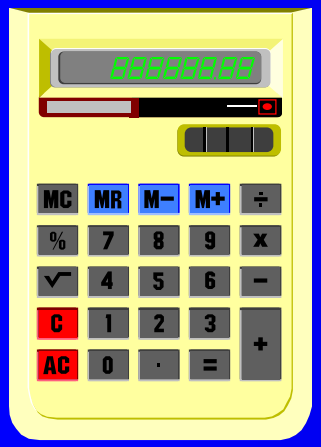
1



Delay Reduction

R/T Workload Reduction

2



Calculation

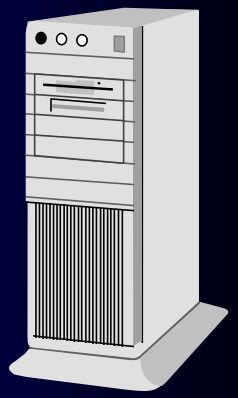
Controller Workload Reduction

3

CAPAN Team

Capacity Increase

4



COSAAC

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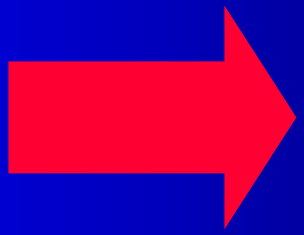
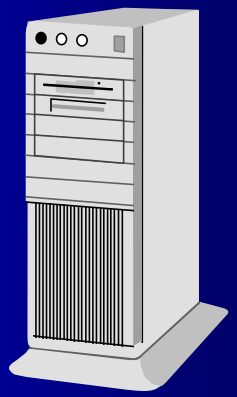
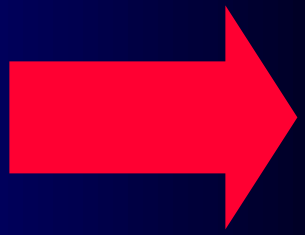
Comms Task Reassessment





CAPAN

Capacity Increase



Confirms steps 2 and 3 of previous exercise