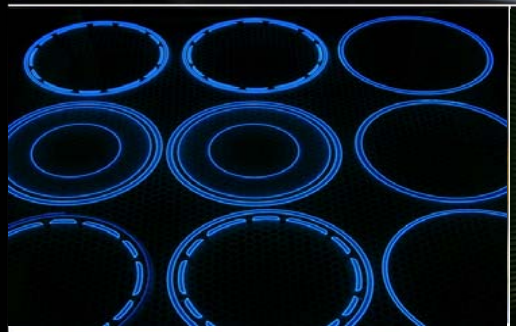
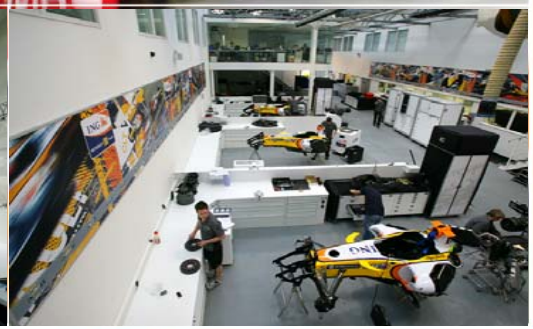




IT and High Performance Computing at Renault F1 Team

Oxford University ICTF Conference - 15TH July 2009

RENAULT F1 Team

The sport of Formula 1

THE SPORT OF FORMULA 1

RENAULT F1 Team

Global sport platform:

10 teams

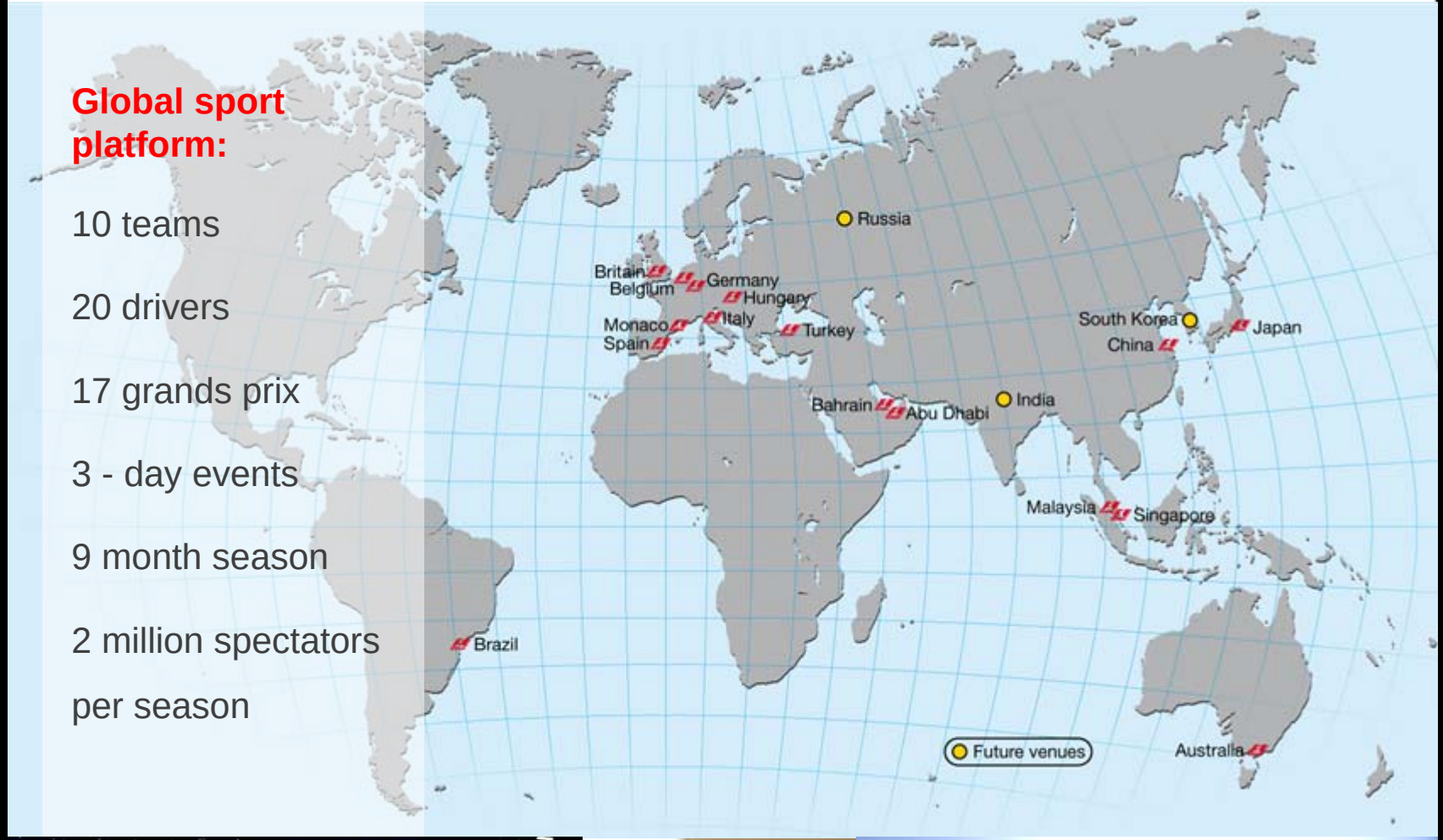
20 drivers

17 grands prix

3 - day events

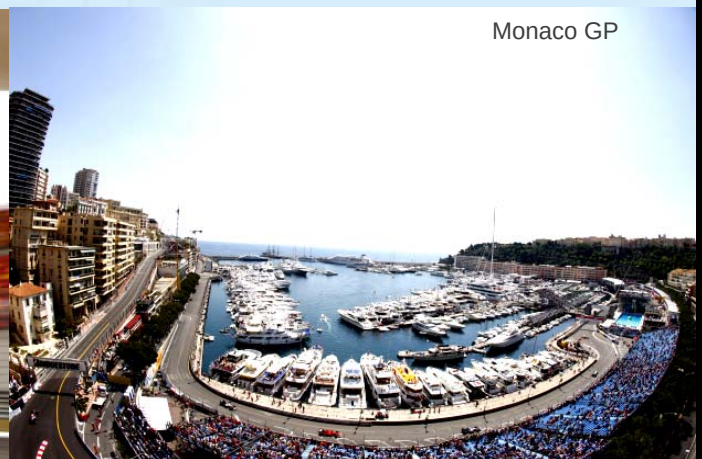
9 month season

2 million spectators per season




Singapore GP – night race


Chinese GP


Monaco GP

F1 GLOBAL REACH

THE SPORT OF FORMULA 1

RENAULT F1 Team

600 million
live TV audience

2.61 billion
cumulative TV audience

188
Countries Broadcasting Formula 1

300
media corps at each race

Formula 1 has unparalleled TV visibility and media interest.

Renault in Formula One

RENAULT IN FORMULA ONE

RENAULT F1 Team

- A history of engineering innovation in Formula 1 since 1977
- Full integration in own Formula 1 team in 2002
- 15 Drivers’ and Manufacturers’ World Championship titles

RENAULT IN FORMULA ONE

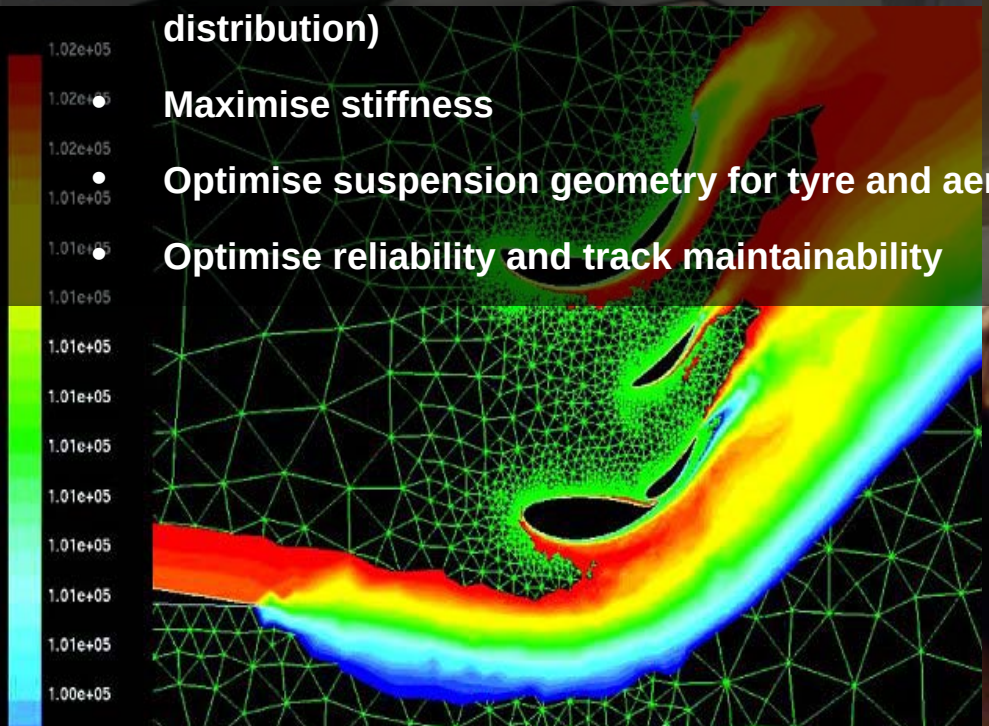
RENAULT F1 Team

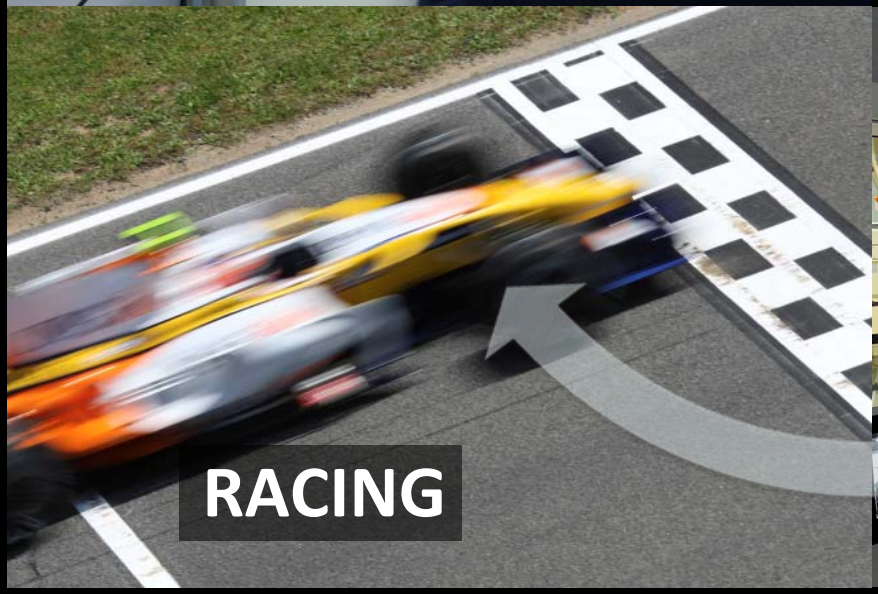
- 115 wins in 426 races, 306 podiums, 154 pole positions
- 6 consecutive Constructors' titles between 1992 and 1997
- Fernando Alonso World Champion in 2005 and 2006
- Flavio Briatore led the team to 7 world championships

A challenging sport

- 90 people travel to each race
- 9 Renault F1 Team trucks to transport 30 tonnes of equipment
- 14 Jumbo Jets fly all the teams' logistics to intercontinental race events
- 17,000 spare parts, 3 cars, 1 spare chassis

- Maximum downforce and minimum drag
- Minimise weight (maximum ballast to optimize centre of gravity and weight distribution)
- Maximise stiffness
- Optimise suspension geometry for tyre and aerodynamic performance
- Optimise reliability and track maintainability





A DATA DRIVEN SPORT

A CHALLENGING SPORT

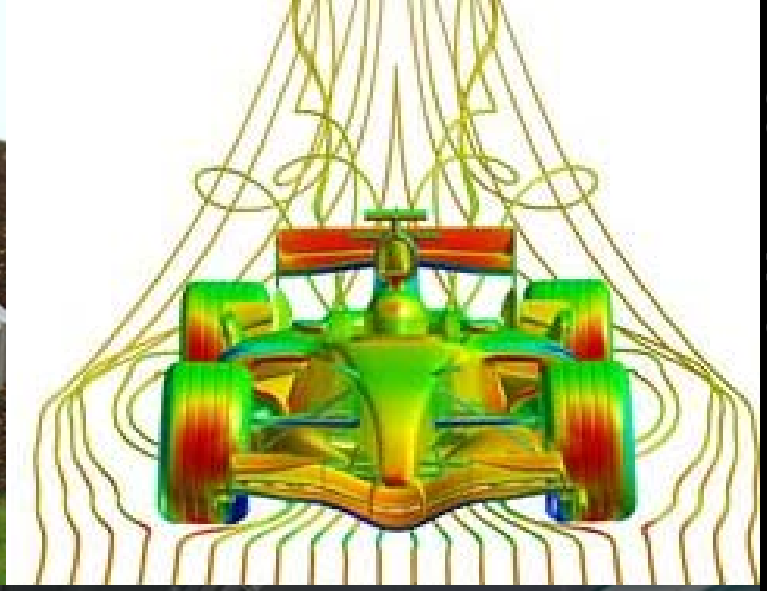
RENAULT F1 Team

48 teraflop super computer
500 terabytes of factory storage
4.5 terabytes of trackside storage
15 megabytes of race data per lap (10 yrs ago a race could be saved on a floppy disc!)

Engine Video Here

- Configuration: 90 degree V8
- Displacement: 2,398 cc
- RPM: up to 18,000 (limited by regulations)
- Weight: 95 kg
- Piston acceleration: up to 10,500 Gs
- Exhaust temperature: 900˚ C
- BHP: more than 700

- More than 150 components
- Dry tyres can exceed operating temperature of 100˚ C and rotate 20-50 times/sec.
- Rain tyres can disperse up to 50 litres of water per second
- 1.2 - 1.3 bar
- Lateral and longitudinal forces up to 5 Gs



AERODYNAMICS

A CHALLENGING SPORT

Wind tunnel operates 24/7

More than 50,000 components evaluated in 2008

More than 2,000 kg downforce at 200 mph/320 km/h

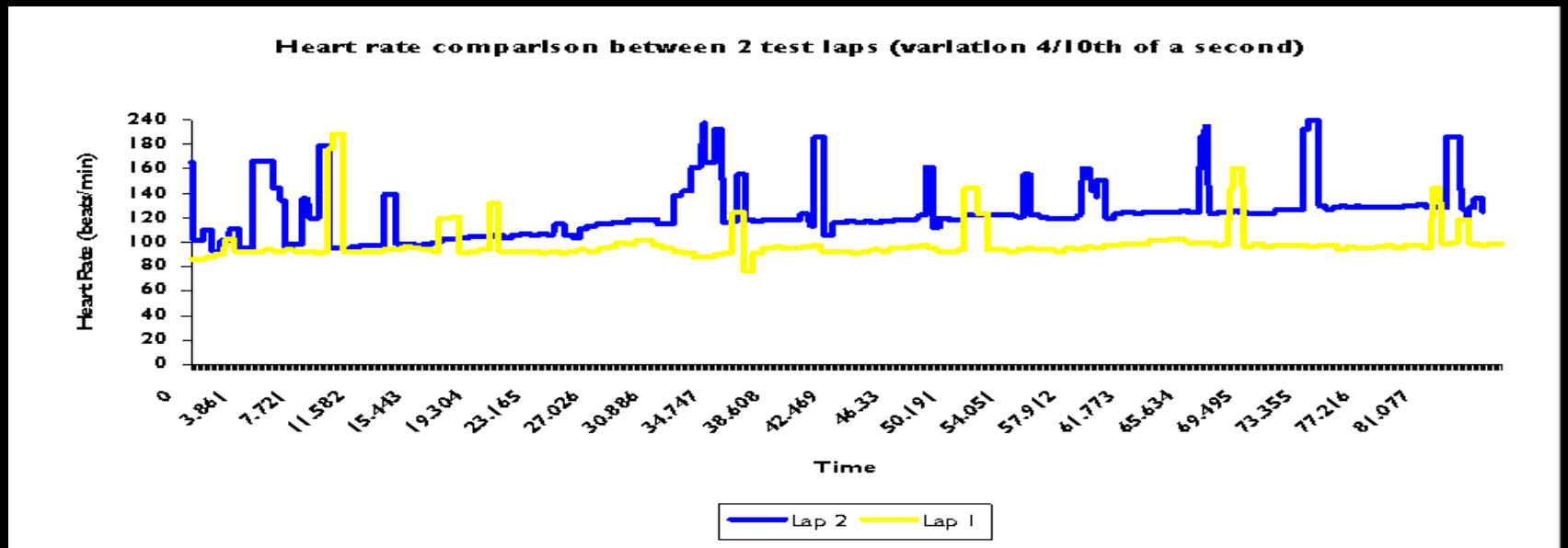
48 Teraflops CFD calculating power and 270 Terabytes of storage

Within 5 most powerful supercomputers in UK

Powered by renewable energy and below ground level to minimise environmental impact

RENAULT F1 Team

- Heart rate 80 bpm - 220 bpm
- Cockpit temperature 60˚ C - 80˚ C
- Dehydration up to 4 kg weight loss
- Lateral and longitudinal forces up to 5 Gs

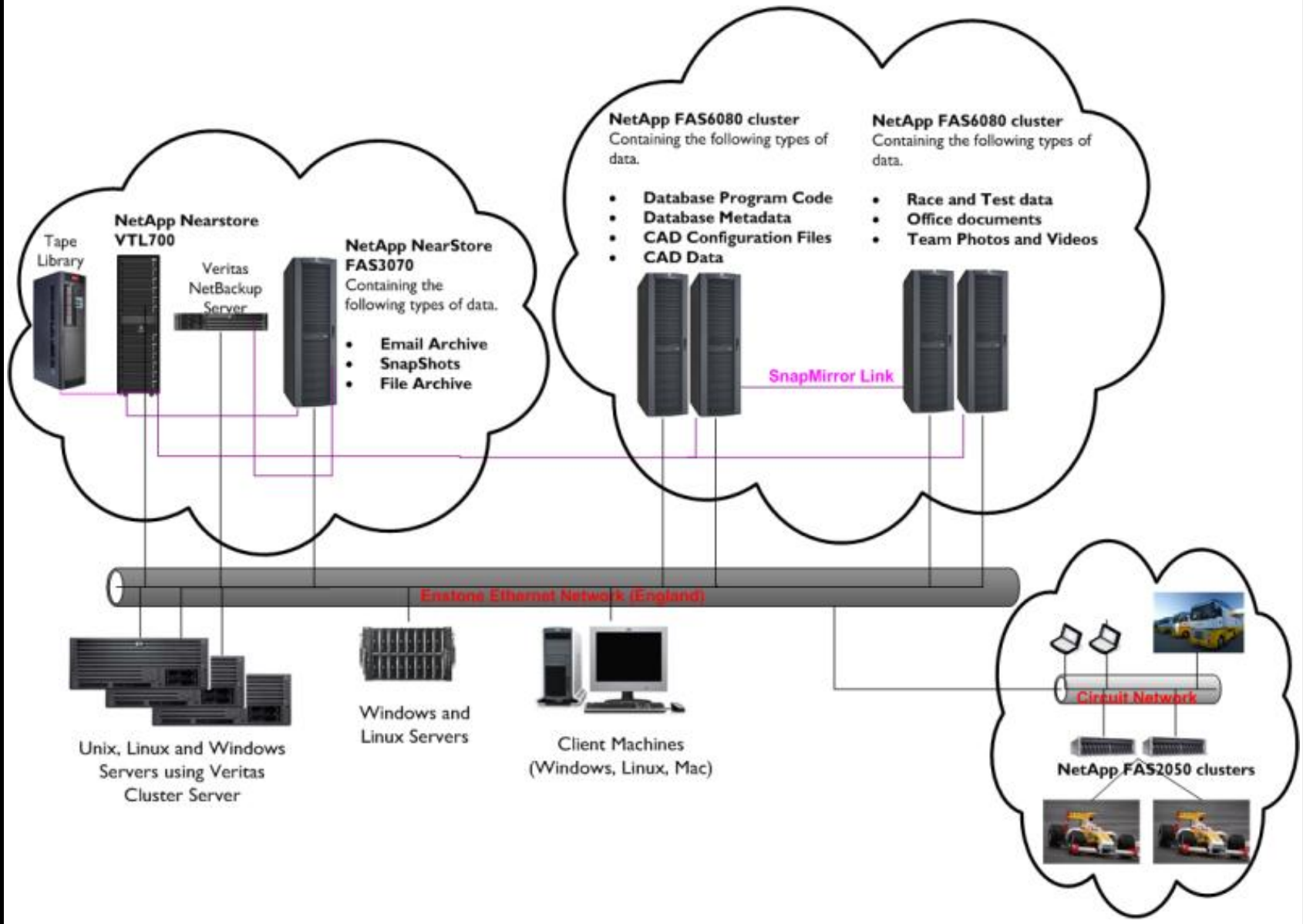


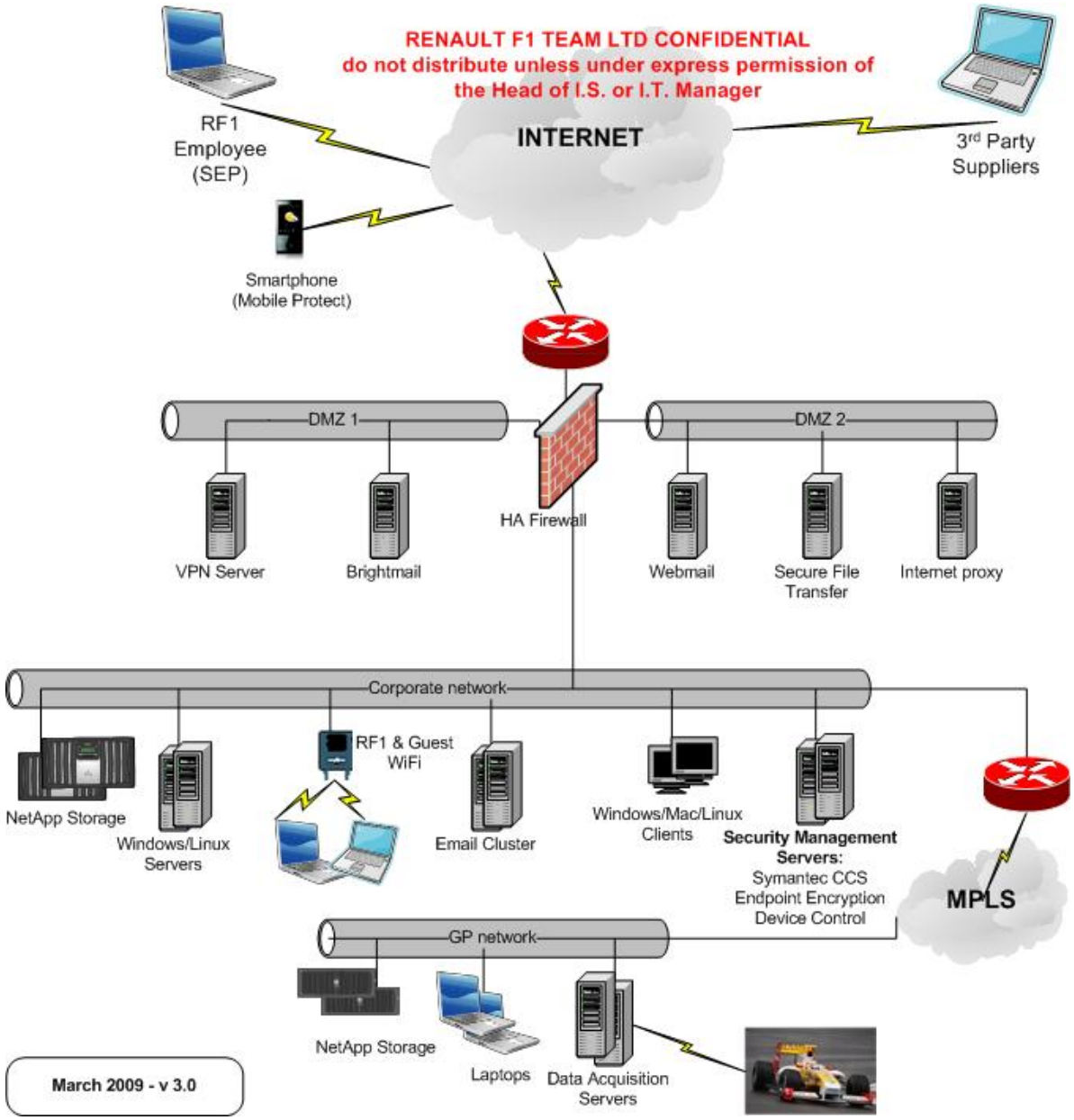
The typical qualifying performance gap over a single lap between the fastest and slowest drivers is about 3 seconds.

The gap separating the top 6 drivers is about 0.6 seconds.

Telemetry Video Here

- Trackside storage capacity: 10 Tb
- High frequency radio used to transmit real-time data
- 200 sensors can create up to 1000 channels
- 10 years ago a floppy disc could contain race data: Now 15Mb/lap


NetApp FAS6080 cluster
Containing the following types of data.
Database Program Code
Database Metadata
CAD Configuration Files
CAD Data
NetApp FAS6080 cluster
Containing the following types of data.
Race and Test data
Office documents
Team Photos and Videos
SnapMirror Link
Tape Library
NetApp Nearstore VTL700
Veritas NetBackup Server
NetApp NearStore FAS3070
Containing the following types of data.
Email Archive
SnapShots
File Archive
Enstone Ethernet Network (England)
Unix, Linux and Windows Servers using Veritas Cluster Server
Windows and Linux Servers
Client Machines (Windows, Linux, Mac)
Circuit Network
NetApp FAS2050 clusters


RENAULT F1 TEAM LTD CONFIDENTIAL
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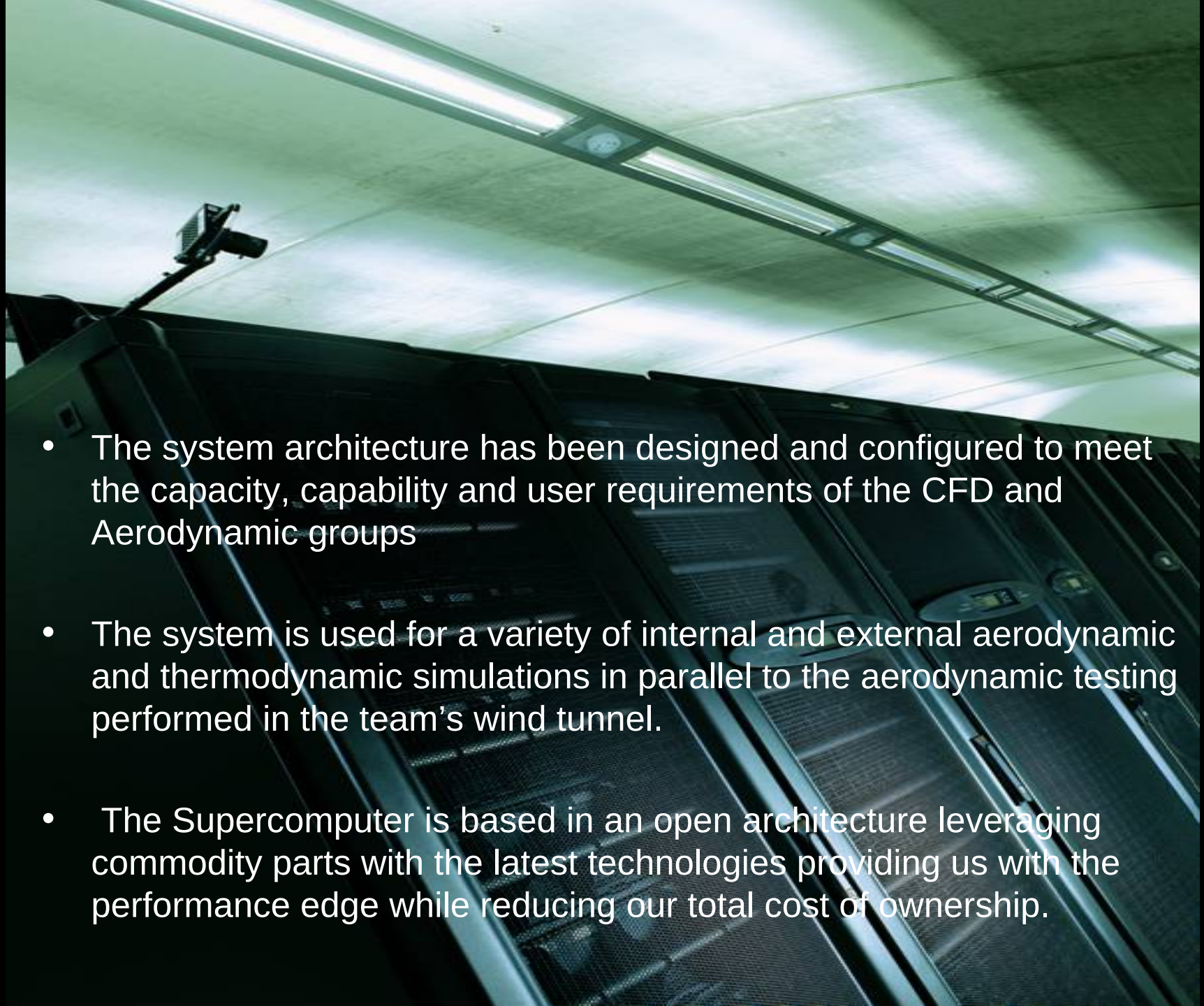
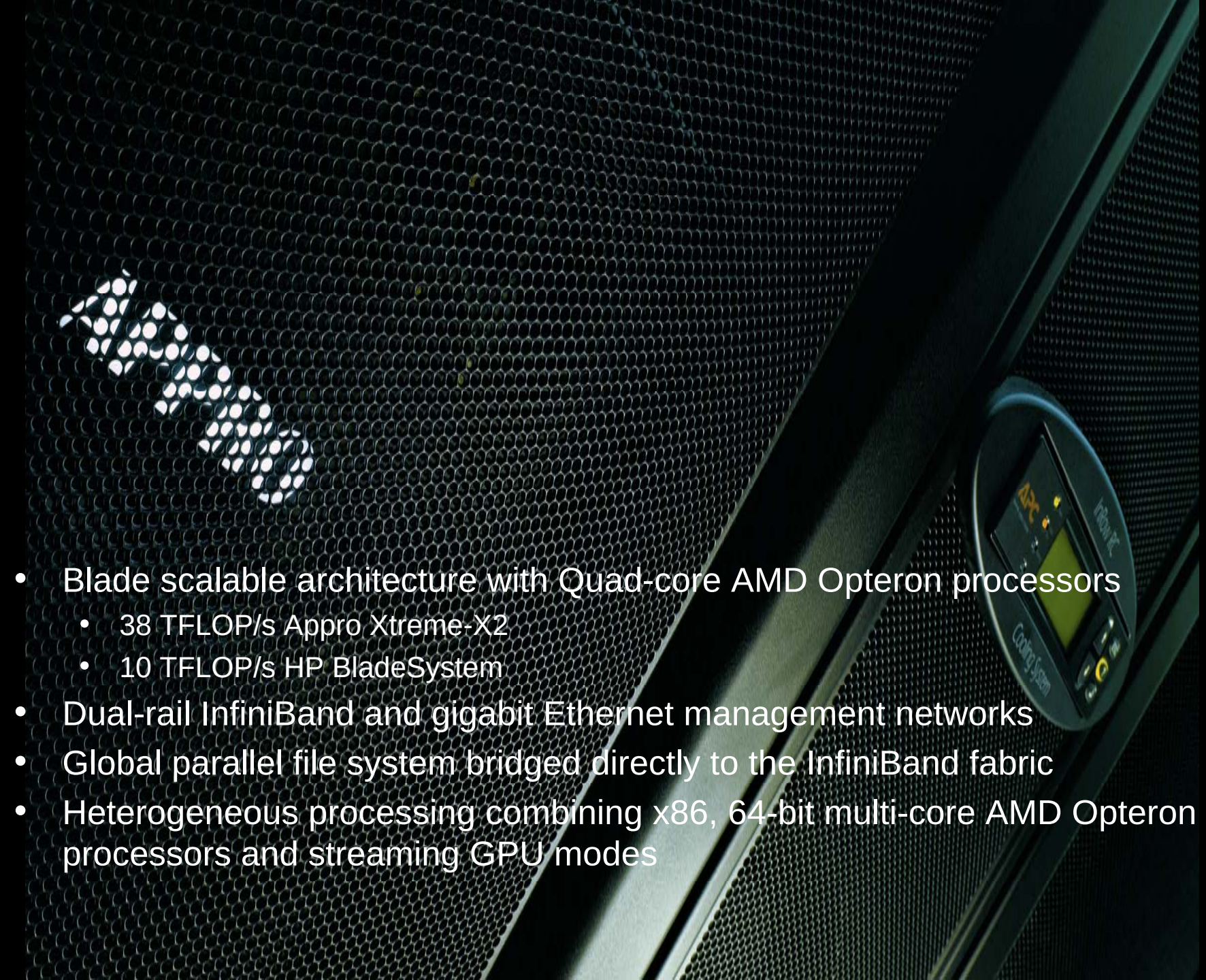
the Head of I.S. or I.T. Manager
INTERNET
RF1
Employee
(SEP)
3rd Party
Suppliers
Smartphone
(Mobile Protect)
DMZ 1
DMZ 2
HA Firewall
VPN Server
Brightmail
Webmail
Secure File
Transfer
Internet proxy
Corporate network
NetApp Storage
Windows/Linux
Servers
RF1 & Guest
WiFi
Email Cluster
Windows/Mac/Linux
Clients
Security Management
Servers:
Symantec CCS
Endpoint Encryption
Device Control
MPLS
GP network
NetApp Storage
Laptops
Data Acquisition
Servers
March 2009 - v 3.0



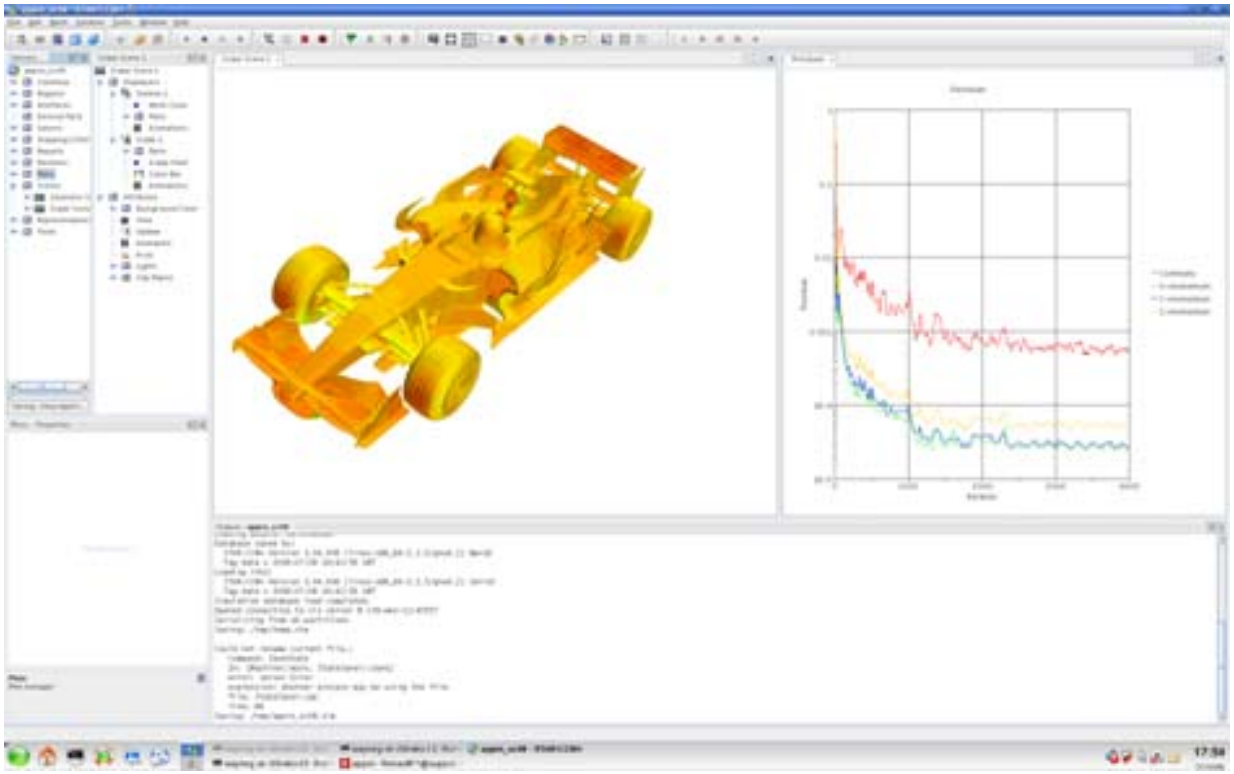
- The system architecture has been designed and configured to meet the capacity, capability and user requirements of the CFD and Aerodynamic groups

- The system is used for a variety of internal and external aerodynamic and thermodynamic simulations in parallel to the aerodynamic testing performed in the team's wind tunnel.

- The Supercomputer is based in an open architecture leveraging commodity parts with the latest technologies providing us with the performance edge while reducing our total cost of ownership.



- Blade scalable architecture with Quad-core AMD Opteron processors
  - 38 TFLOP/s Appro Xtreme-X2
  - 10 TFLOP/s HP BladeSystem
- Dual-rail InfiniBand and gigabit Ethernet management networks
- Global parallel file system bridged directly to the InfiniBand fabric
- Heterogeneous processing combining x86, 64-bit multi-core AMD Opteron processors and streaming GPU modes



The commercial (Star-CCM+ supplied by CD-Adapco) and non-commercial CFD solvers typically used by the CFD group are suited to distributed memory or “cluster” architectures employing the standard Message Passing Interface (MPI) for inter-process communication.

MEDIUM TERM CHALLENGES

FOR INFORMATION SYSTEMS:

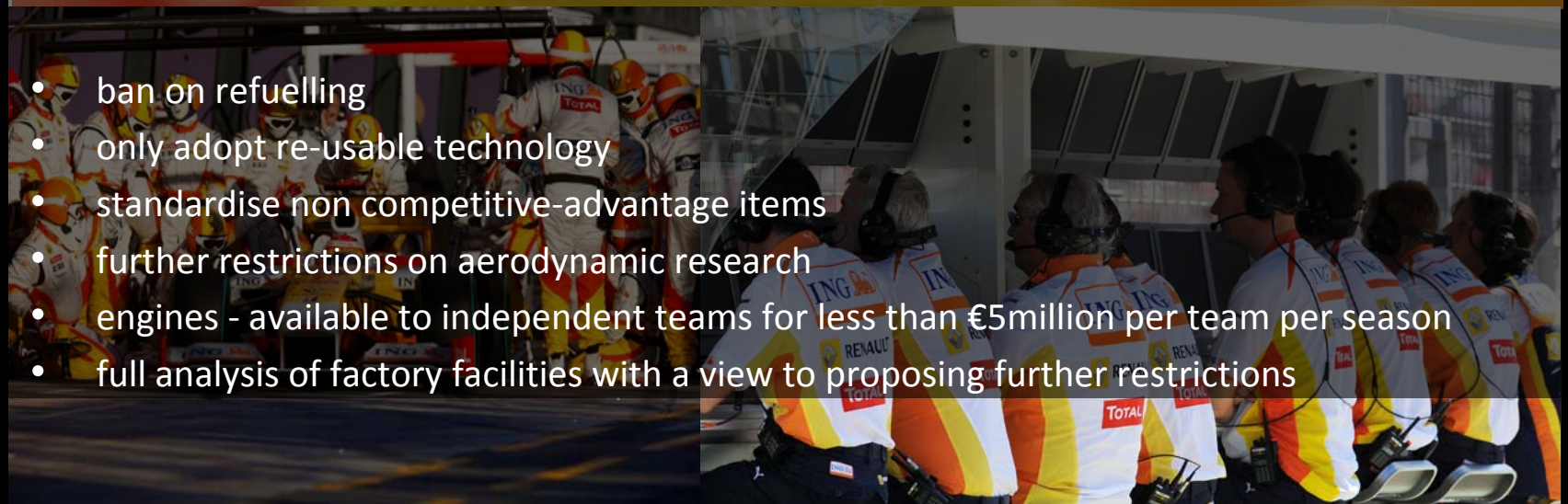
- Data Management/Security
- IT Service Management (which will involve a culture change)
- Trackside software tools
- Numerically Intensive Computing (Track/CFD/Stress/VTG)
- Budget allocation/Value on Investment

FOR THE BUSINESS:

- Reduced Track Testing (Simulation)
- “Green” F1 (Kinetic Energy Recovery Systems)
- Technical restrictions
  - “Diffusergate”
  - Increase Aerodynamic Output within FOTA restrictions
- Budget restrictions

RENAULT F1 Team

- manpower reduced
- engine life to be doubled, max 20 per team per season
- no in-season testing except during race weekend during scheduled practice
- no wind tunnel exceeding 60% scale and 50 metres/sec
- factory closures for two weeks per year



- ban on refuelling
- only adopt re-usable technology
- standardise non competitive-advantage items
- further restrictions on aerodynamic research
- engines - available to independent teams for less than €5million per team per season
- full analysis of factory facilities with a view to proposing further restrictions

THANK YOU

Graeme K. Hackland MBCS CITP
CTO - IT

RENAULT F1 Team