



Reaching into space  
**TOGETHER**

# VTS: Visualization Tool for Space data

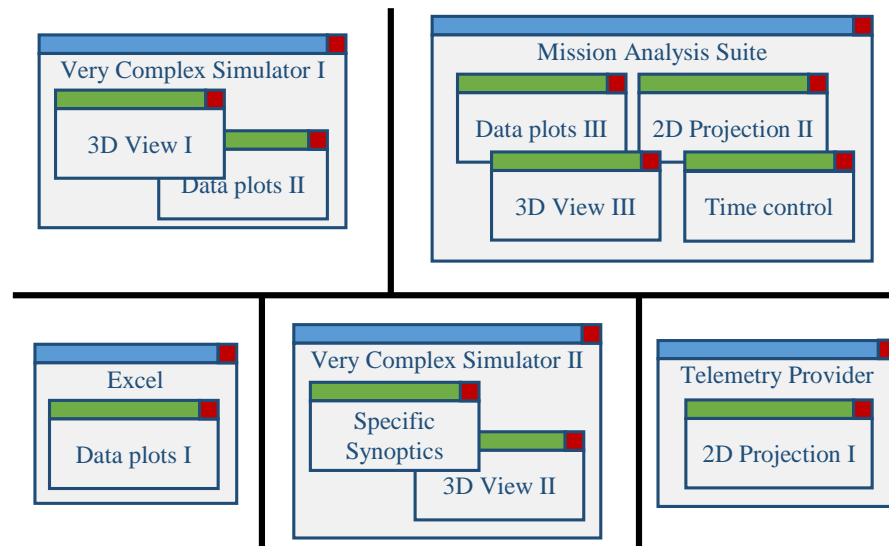
A long-term approach for synchronization of all  
visualization software

*SESP 2015*



# Birth of visualization software (1/2)

- Without any agency-wide collaboration
  - 1 data producer tool = 1 visualization solution

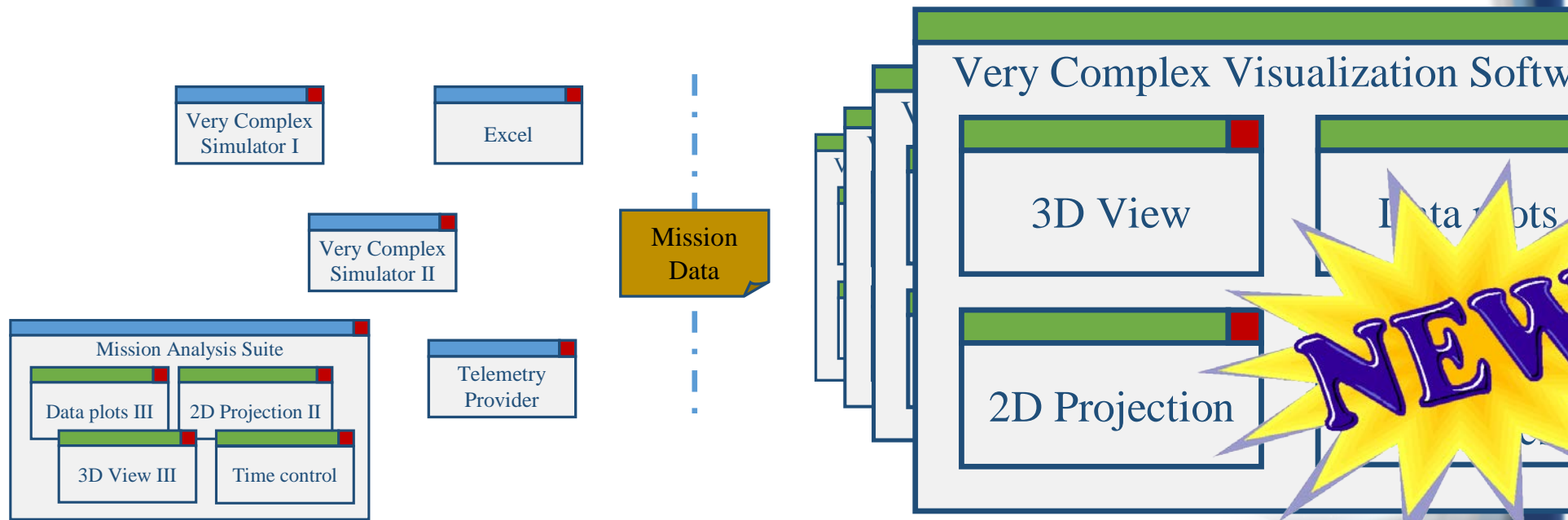


“Reinventing the wheel” approach



# Birth of visualization software (2/2)

- Attempt at global collaboration
  - N data producer tools = 1 blanket solution



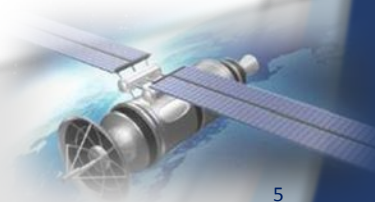
# The challenge

- Create a future-proof visualization framework
  - No future event should question the tool
- Cover new requirements with ease
  - New specific needs are the prime motivation for the creation of new visualization software
- Integrate existing software and libraries
  - Including highly specialized software

This is the “raison d’être” of VTS

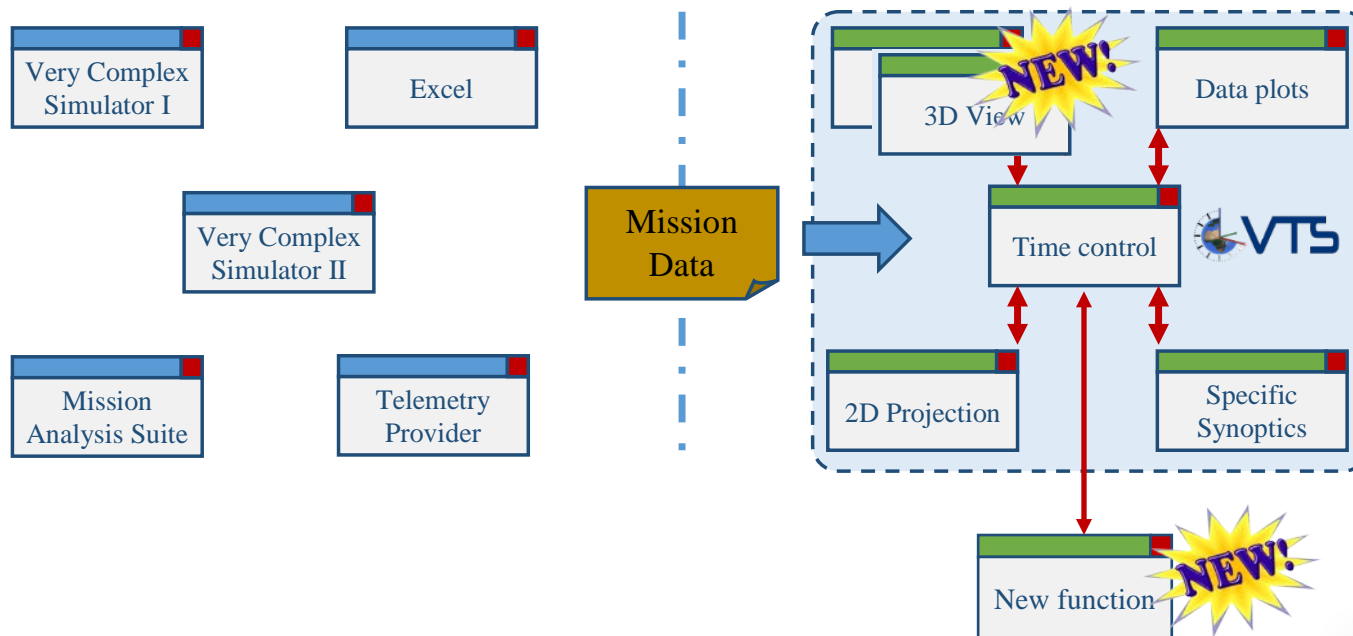
# Overview

- Introducing VTS
- Talk highlights
  - *What are the main technical choices?*
  - *Why was VTS so widely adopted?*
  - *What are the main benefits for CNES?*



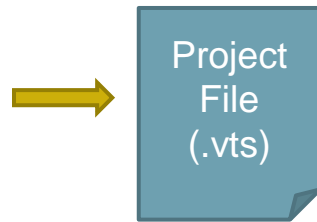
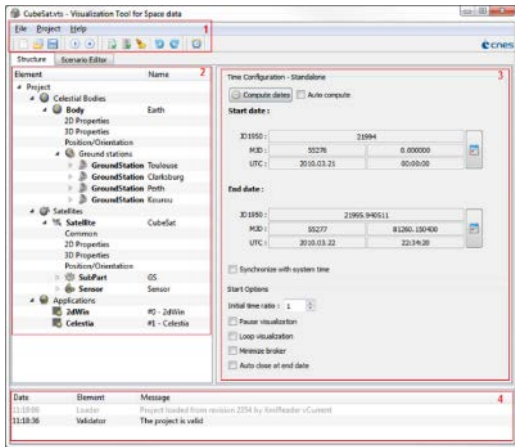
# Core idea of VTS

- Connect and synchronize specialized visualization software
  - Functional coverage is provided by several independent tools

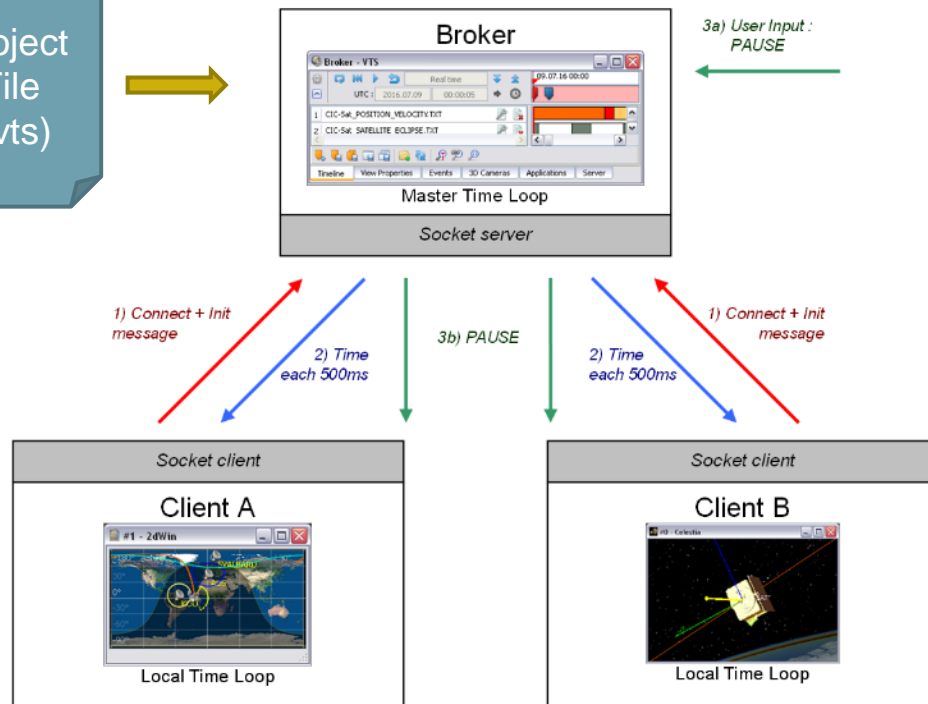


# Schematic diagram

## 1) Common Configuration



## 2) Synchronized Visualization



# Candidate software

- Any Time-based visualization software

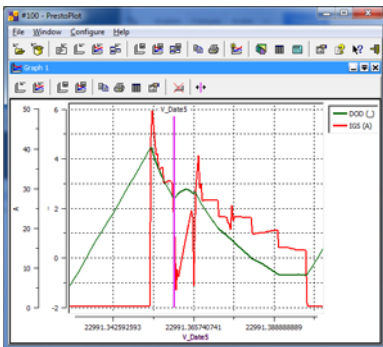
PLOT

3D

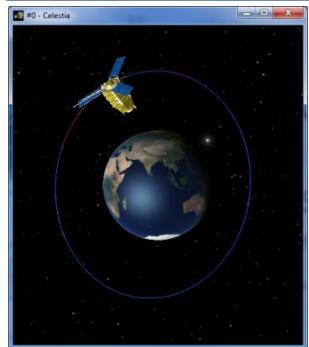
2D

TABLE

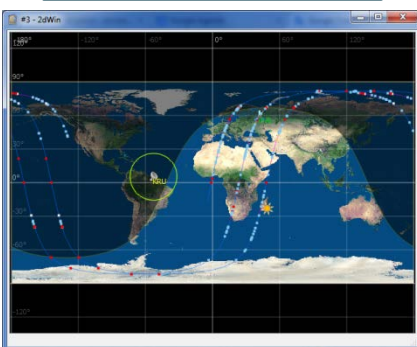
SYNOPTIC



Value =  $f(t)$

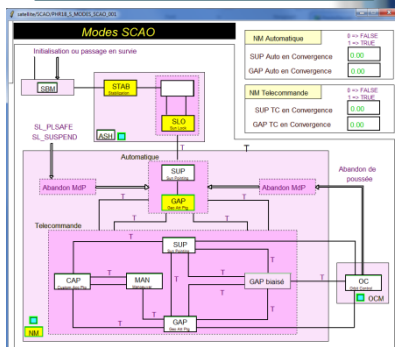


Attitude and position =  $f(t)$



Latitude and longitude =  $f(t)$

Current line =  $f(t)$



State =  $f(t)$





# Runtime example

The screenshot displays the VTS (Vehicular Telemetry System) interface during a runtime example. The interface is divided into several main sections:

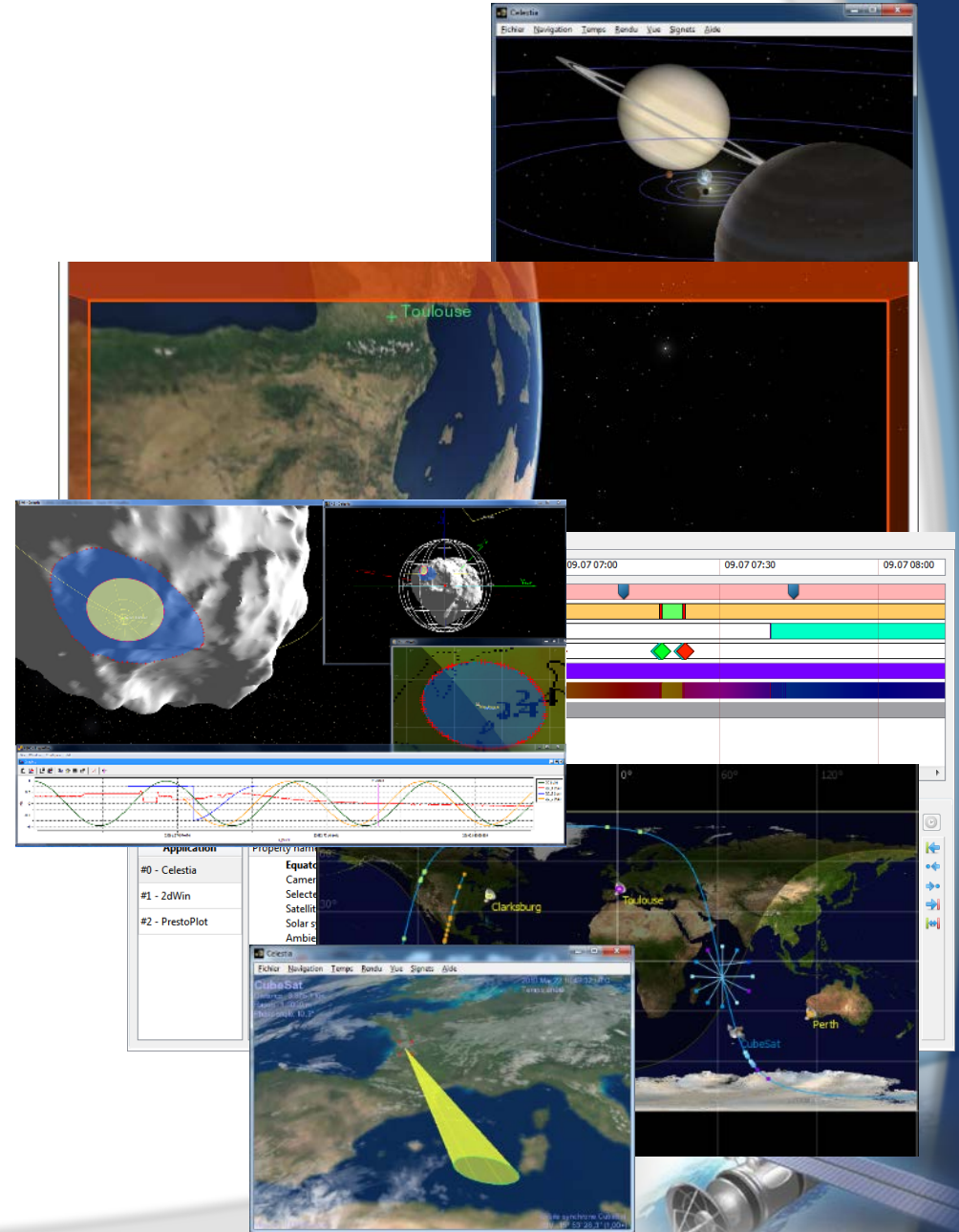
- Top Left:** A window titled "Broker - VTS - PHR\_TM\_20121212-Demo4.vts" showing a timeline from 12:12:08:30 to 12:12:09:00. It lists events for PHR and attitude/modes data files.
- Top Right:** A window titled "PROTON - BDS PHR1A" showing a table of TC (Transfer Command) events. The selected entry is "CHMTLMTFTIB Transfer intermediate TC buffer".
- Bottom Left:** A 3D visualization of the Earth with satellite orbits plotted. A specific satellite is highlighted with a green circle and labeled "PRU".
- Bottom Right:** A "VestoPlot" window showing a graph of data over time. The x-axis represents time (e.g., 22991.342592593) and the y-axis represents a value (e.g., 50). Two data series are shown: "DOD (J)" in green and "IGS (A)" in red.

Yellow arrows indicate the flow of information and synchronization between these components:

- Arrows point from the event logs to the 3D orbit visualization.
- Arrows point from the 3D orbit visualization to the TC logbook table.
- Arrows point from the TC logbook table to the VestoPlot graph.
- Arrows point from the VestoPlot graph back to the event logs.

# Sample features

- Timeline display
- Handy predefined cameras
- Sensor volume and swath
- Events on ground track
- Points/Regions Of Interest
- Full context save/restore
- Scripting
- Video capture
- ...



# Origin of data used by VTS

- Files (replay mode)

- Network streams (real-time)

- Spacecraft simulator
- Operations center

```

CIC_OEM_VERS = 2.0
CREATION_DATE = 2009-12-08T09:00:00
ORIGINATOR = CNES

META_START
OBJECT_NAME = CubeSat
OBJECT_ID = CubeSat
CENTER_NAME = EARTH
REF_FRAME = EME2000
TIME_SYSTEM = UTC

META_STOP
55276 0.000 4264.085921 -832.254441 5618.208465
55276 30.000 4421.338968 -916.904119 5481.941484
55276 60.000 4574.176227 -1000.637990 5340.185449
55276 90.000 4722.444369 -1083.372281 5193.081475
55276 120.000 4865.994574 -1165.024190 5040.776067
CIC-Sat_ROTATION_ANGLE_SA_1.txt
CIC-Sat_SATELLITE_ECLIPSE.TXT
CIC-Sat_SATELLITE_CONSUMED_POWER.txt
CIC-Sat_SATELLITE_MODES.txt
CIC-Sat_COLOR.TXT
CIC-Sat_ROTATION_panneau_externe_SA_1_0.TXT
CIC-Sat_ROTATION_panneau_interne_SA_1_0.TXT
  
```



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# Technical points (1/3)

- Single XML configuration file
  - Holds all configuration information for a visualization
  - Easy to share
  - Verbose & easy to understand
  - Easy to generate or manipulate programmatically



# Technical points (2/3)

- Human-readable input data format
  - Holds any type of data (incl. ephemerides)
  - Simple structure and format
  - Easy to generate either by hand or programmatically
  - Follows CNES' own "CIC" standard

```
CIC_OEM_VERS = 2.0
CREATION_DATE = 2012-03-29T11:35:51.706
ORIGINATOR = CNES - DCT/SB/MS
```

```
META_START
OBJECT_NAME = CIC-Sat
OBJECT_ID = CIC-Sat
CENTER_NAME = EARTH
REF_FRAME = ICRF
TIME_SYSTEM = UTC
META_STOP
```

```
57578 0.00000 -648.783 -6953.936 -15.097
57578 10.00000 -658.843 -6952.662 59.783
57578 20.00000 -668.826 -6950.573 134.657
57578 30.00000 -678.731 -6947.671 209.514
```

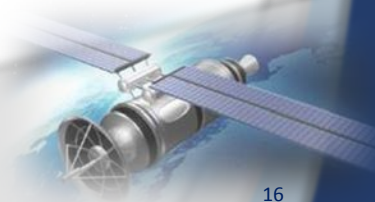


# Technical points (3/3)

- Extensible synchronization protocol
  - Carries time sync, command messages, data streams
  - Plain text messages
  - Extensible to transmit application-specific messages
  - Two-way link
  - Fully documented
  - Stable and backwards compatible
- Single required interface with VTS

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# Core functional scope

## Adressed by VTS:

- Visualization
- Synchronization

## NOT adressed by VTS:

- Orbit propagation
- Attitude generation
- Environment models
- Mission analysis / models
- Satellite simulation
- Electrical and thermal simulation

# Philosophy

- Excel at the core features
- Respect of project expertise
  - Rely on project tools for out-of-scope functionality
  - Relay data as-is from producers to consumers
- Strive for a hassle-free user experience
  - User-friendly
  - Customizable
  - Easy integration



# VTS users

- 100+ daily users at CNES
- 500+ recent downloads
- Agencies: CNES, ESA, ESTEC, NASA, JPL, etc.
- Many universities
- Industry: Airbus, Thalès, etc.
- Personal users



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# Benefits

- Best use of existing tools through third-party software integration
- Long-term adequacy through interchangeable components
- Better interoperability between all compatible visualization tools thanks to shared minimum set of functionality
- Indirect idea-sharing as new features are made available to all users



# Conclusions

- VTS is a generic, modular and open visualization suite
- Designed to:
  - Empower existing tools rather than replace them
  - And accelerate the development of new ones
- With a strong focus on user experience
- Great asset throughout the whole S/C life cycle
- Gaining strong momentum in and outside CNES



# Try it!

- Portable, multi-plateform, free
- Operational in a few minutes :
  - Download VTS (Google : VTS Timeloop, [www.timeloop.fr](http://www.timeloop.fr))
  - Extract and launch startVTS.exe
  - Project/Open : Data/CubeSat/CubeSat.vts
  - Hit “Play”
- Documented (available in the software package)
  - User manual : English language, comprehensive, 160 pages
  - Data files format : “CIC” format specification

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**Thank you for your attention!**

