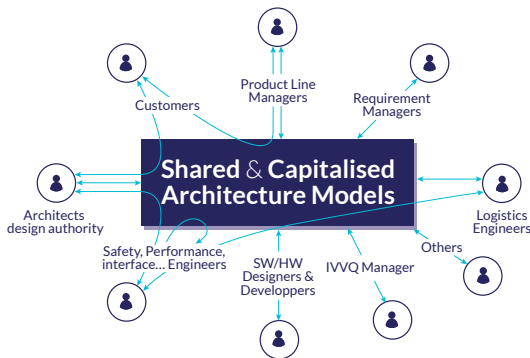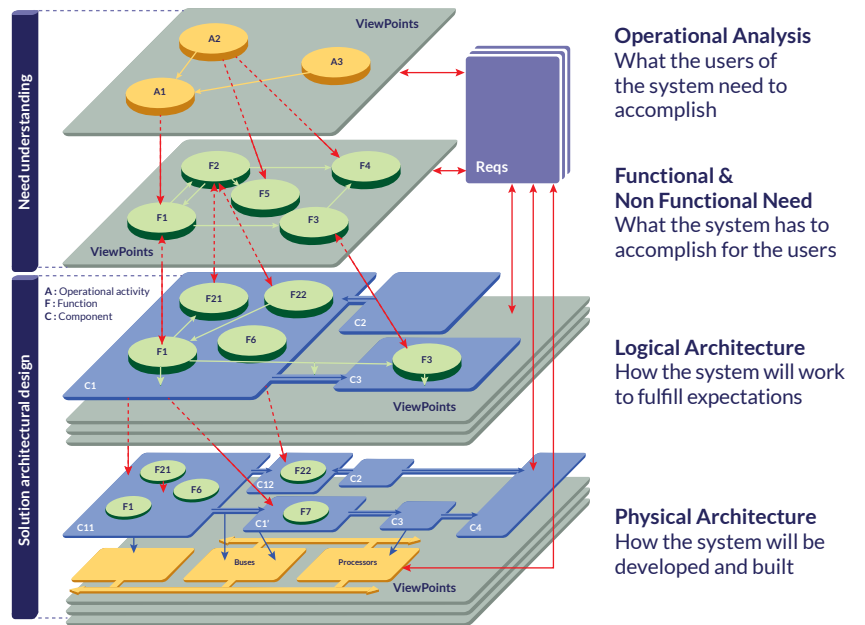# ARCADIA

A TOOLED METHOD TO

Define, Analyse, Design & Validate System, Software, Hardware Architectures
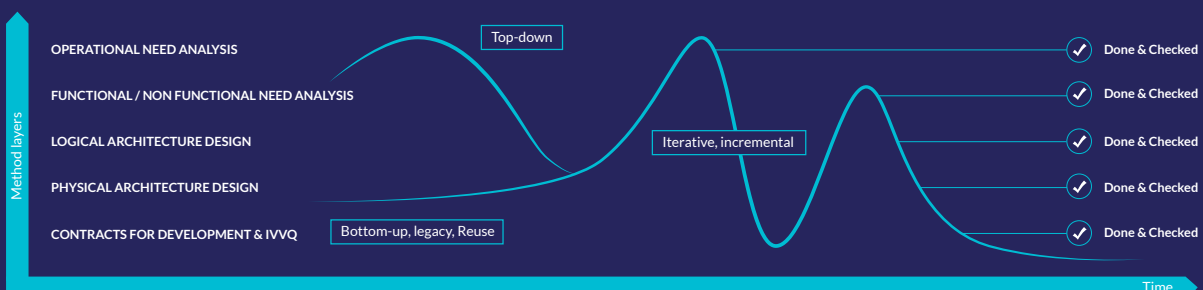
Supporting Efficient Collaboration in Engineering

Customers
Product Line Managers
Requirement Managers

Shared & Capitalised Architecture Models

Architects design authority
Logistics Engineers
Safety, Performance, interface… Engineers
SW/HW Designers & Developpers
IVVQ Manager
Others

Validating/Justifying solution against Operational Need Easing Impact Analysis

Need understanding

Solution architectural design

ViewPoints
A2
A1
A3

F2
F4
F5
F1
F3
ViewPoints

A : Operational activity
F : Function
C : Component

F21
F22
C2
F1
F6
F3
C1
C3
ViewPoints

F21
F22
C2
F6
C12
F1
F7
C11
C1'
C3
C4
Buses
Processors
ViewPoints

Reqs

Operational Analysis
What the users of the system need to accomplish

Functional & Non Functional Need
What the system has to accomplish for the users

Logical Architecture
How the system will work to fulfill expectations

Physical Architecture
How the system will be developed and built

Compatible with most processes
top-down bottom-up, iterative, legacy-based, mixed …

Method layers

OPERATIONAL NEED ANALYSIS
FUNCTIONAL / NON FUNCTIONAL NEED ANALYSIS
LOGICAL ARCHITECTURE DESIGN
PHYSICAL ARCHITECTURE DESIGN
CONTRACTS FOR DEVELOPMENT & IVVQ

Top-down
Iterative, incremental
Bottom-up, legacy, Reuse

Done & Checked
Done & Checked
Done & Checked
Done & Checked
Done & Checked

Time

NEED

Customer Operational Need Analysis

What the users of the system need to accomplish

- ✓ Define operational capabilities
- ✓ Perform an operational need analysis

BROADCASTING STATION — Elaborate Radio Programs
Radio contents
ENVIRONMENT — Broadcast Radio channels
News Radio channel
Music Radio channel
USER — Get news / Listen to Music
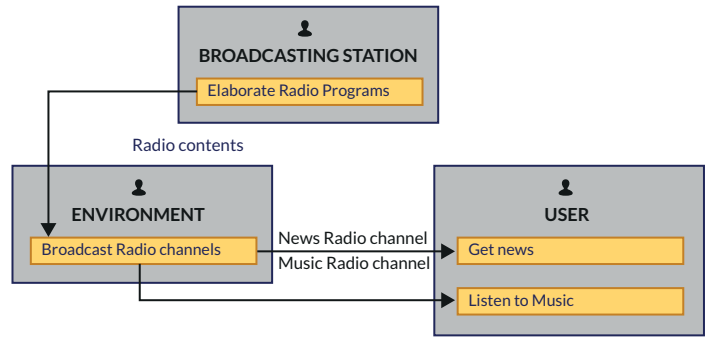
System/ SW/HW Need Analysis
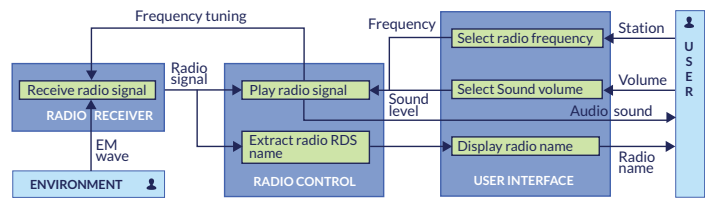
What the system has to accomplish for the Users

- ✓ Perform a capability trade-off analysis
- ✓ Perform a functional and non-functional analysis
- ✓ Formalise and consolidate requirements

ENVIRONMENT — EM waves — Receive radio signal — Radio signal — Play radio contents
Select radio station — Station
Fréquency
Volume
USER
Audio sound
Radio name
RADIO SET

SOLUTIONS
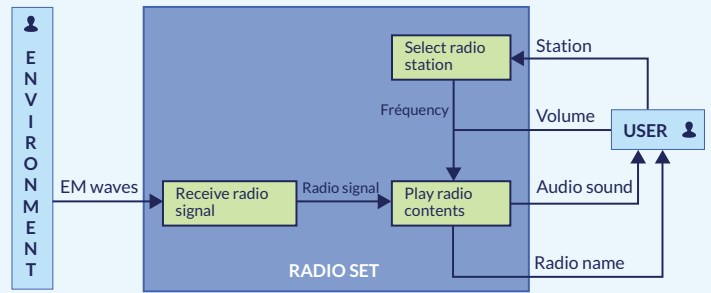
Logical Architecture Design

How the system will work so as to fulfil expectations
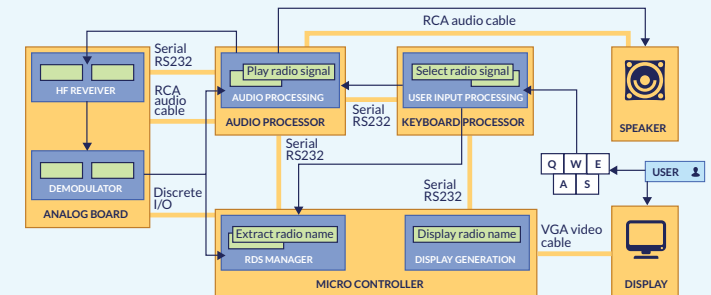
- ✓ Define architecture drivers and viewpoints
- ✓ Build candidate architectural breakdowns in components
- ✓ Select best compromise architecture

Frequency tuning
Frequency
Receive radio signal — Radio signal — Play radio signal
RADIO RECEIVER
Extract radio RDS name
Select radio frequency — Station
Select Sound volume — Volume
Display radio name — Radio name
Sound level — Audio sound
ENVIRONMENT — EM wave
RADIO CONTROL
USER INTERFACE
USER

Physical Architecture Design
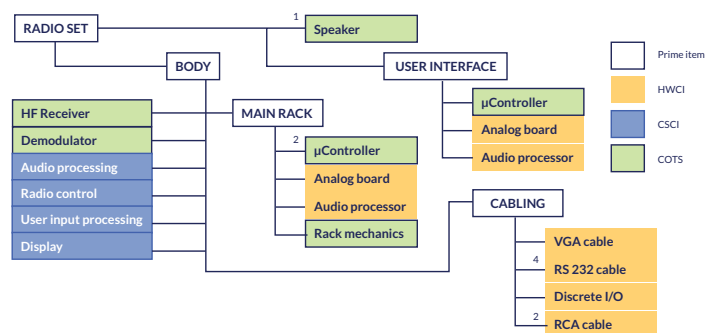
How the system will be developed & built

- ✓ Define architectural patterns
- ✓ Consider reuse of existing assets design a physical
- ✓ Design a physical reference architecture
- ✓ Validate and check it

HF REVEIVER
Serial RS232
RCA audio cable
DEMODULATOR — Discrete I/O
ANALOG BOARD
Play radio signal — AUDIO PROCESSING
AUDIO PROCESSOR
Select radio signal — USER INPUT PROCESSING
KEYBOARD PROCESSOR
Serial RS232
RCA audio cable
SPEAKER
Extract radio name — RDS MANAGER
Display radio name — DISPLAY GENERATION
MICRO CONTROLLER
USER
VGA video cable
DISPLAY

Development Contracts

What is expected from each designer/ sub-contractor

- ✓ Define a components IVVQ strategy
- ✓ Define & enforce a PBS and component integration contract

RADIO SET — Speaker
BODY
USER INTERFACE
HF Receiver
Demodulator
Audio processing
Radio control
User input processing
Display
MAIN RACK
µController
Analog board
Audio processor
Rack mechanics
µController
Analog board
Audio processor
CABLING
VGA cable
RS 232 cable
Discrete I/O
RCA cable

Legend:
- Prime item
- HWCI
- CSCI
- COTS

- Operational capabilities
- Actors, operational entities
- Actor activities
- Interactions between activities & actors
- Information used in activities & interactions
- Operational processes chaining activities
- Scenarios for dynamic behaviour

Dataflow: functions, op. activities interactions & exchanges

Scenarios: actors, system, components interactions & exchanges

- Actors and system, capabilities
- Functions of system & actors
- Dataflow exchanges between functions
- Functional chains traversing dataflow
- Information used in functions & exchanges, data model
- Scenarios for dynamic behaviour
- Modes & states

Functional chains, operational processes through functions & op. activities

START
MODE 1
MODE 3
MODE 2
END

Modes & states of actors, system, components

SAME CONCEPTS, PLUS :
- Components
- Component ports and interfaces
- Exchanges between components
- Function allocation to components
- Component interface justification by functional exchanges allocation

Breakdown of functions & components

SOUND PROFILE
is composed of
TUNING VALUE
Values : From 0 to +100
LOUDNESS
TREBLE LEVEL
uses
FREQUENCY BAND
Values : 0.1, 0.2, 3.0, 6.0
Unit : KHz
BASS LEVEL
FREQUENCY
Values : From 88 to +108
Unit : MHz
is kind of
FILTER VALUE
Values : From -50 to +50
Unit : dB

Data model: dataflow & scenario contents, definition & justification of interfaces
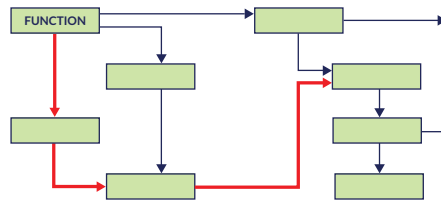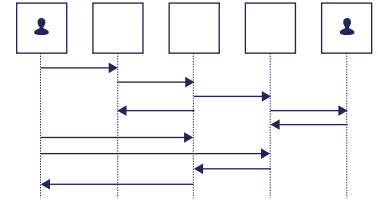
SAME CONCEPTS, PLUS :
- Behavioural components refining logical ones, and implementing functional behaviour
- Implementation components supplying resources for behavioural components
- Physical links between implementation components

ACTOR 1
ACTOR 2

Component wiring: all kinds of components

- Configuration items tree
- Parts numbers, quantities
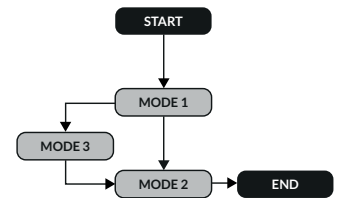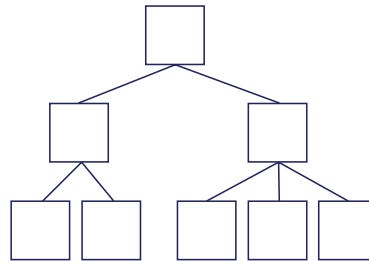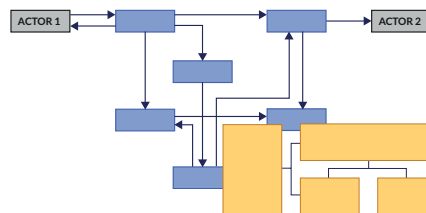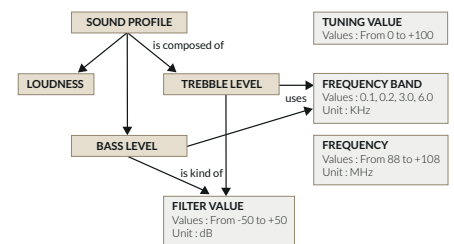- Development contract (expected behaviour, interfaces, scenarios, resource consumption, non-functional properties…)

FUNCTION
Functional Flow
BEHAVIORAL COMPONENT
BEHAVIORAL COMPONENT

Allocation of op.activities to actors, of functions to components, of behav.components to impl.components, of dataflows to interfaces, of elements to configuration items

System

User

Function

Function

Function

DATA

Enable
Disable
Activates

MODE

MODE

Triggers

References

USER

References

SYSTEM

Mode or State

Function

Mode or State

References
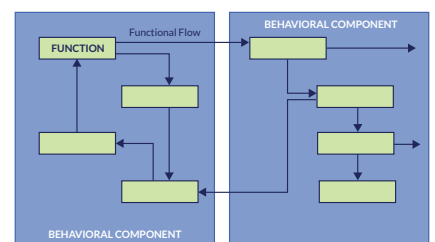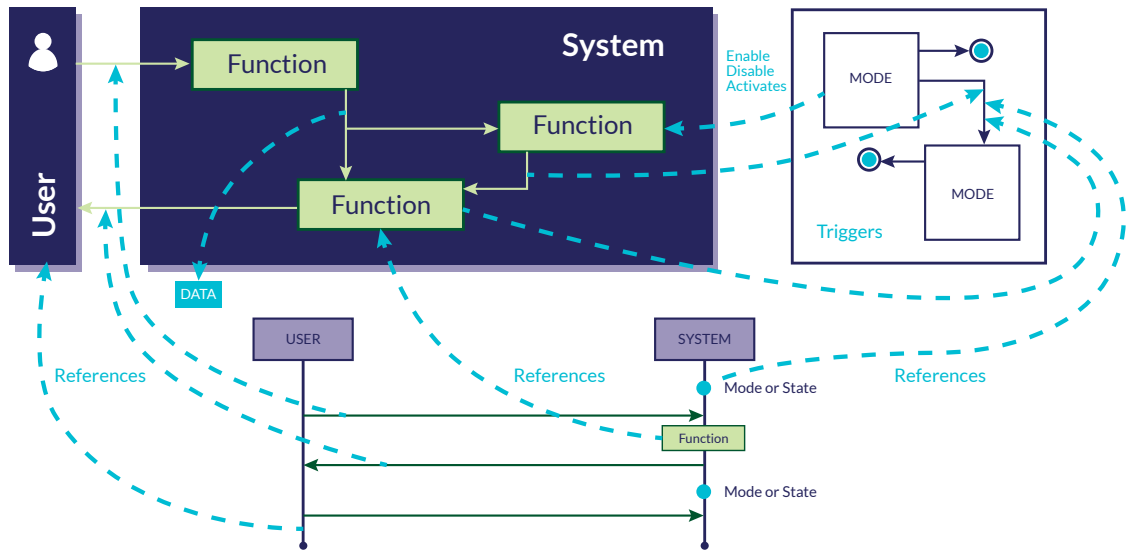
Verifying & checking solution against
Non-functional & Industrial Stakes

Method layers	Performance specific data sample	Safety specific data sample
OPERATIONAL NEED ANALYSIS	Max reaction time to threat	Feared events
FUNCTIONAL/NON FUNCTIONAL NEED ANALYSIS	Functional chain (FC) to react to threat. Maximum allowed latency on FC	Critical functional chains associated to events
LOGICAL ARCHITECTURE DESIGN	Processing & exchanges complexity Functional chains allocation	Redundancy paths securing functional chains
PHYSICAL ARCHITECTURE DESIGN	Resource consumption on FC Resulting computing latency	Common failure modes Fault propagation on FC
CONTRACTS FOR DEVELOPMENT & IVVQ	Allocated resources to satisfy latency	Needed reliability level

✔ Cost & Schedule

✔ Interfaces

✔ Performance

✔ Maintainability

✔ Safety/security

✔ ...

✔ IVVQ

✔ Product Policy

< 2 seconds

Operational performance

Latency :
New attribute of functional chain (expected + computed)

Safety

R1

R2

R3

A

B

VOTE

C

Redundancy :
Extension of functional chain

Voter :
Extension of component

Technical performance

CLIENT

Server 1

Server 2

Load balanced cluster :
New concept

Resulting architecture

Functions or components

ARCHITECTURE CHECK

- Compute function traversal time according to implem component & comms perf
- Deduce achieved latency & compare to expected

- Compare redundancy level with functional chain criticity
- Propagate HW failures to functional chains

- Compute load based on functions & check adequacy
- Both on computing power and communication bandwidth

MULTI-VIEWPOINT
CHECK OF ARCHITECTURE

THALES