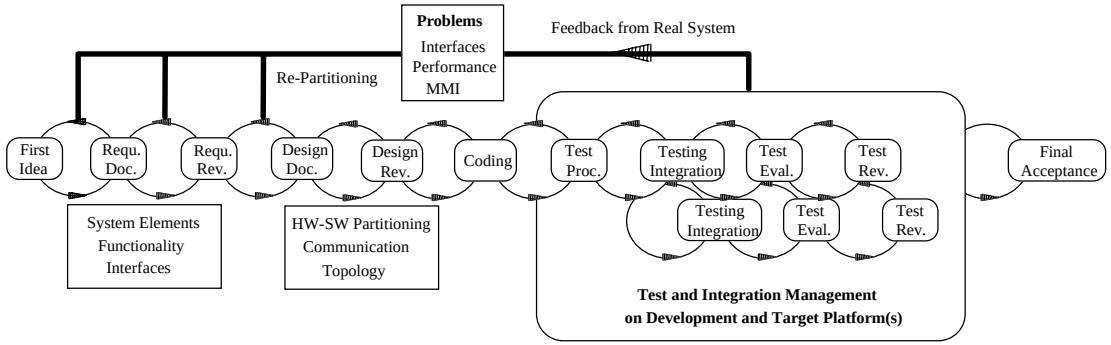
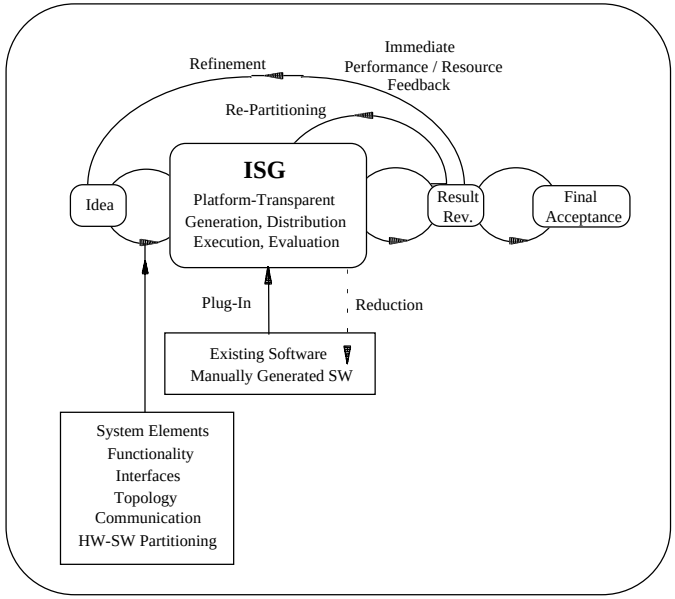
Be Faster on The Market at Less Costs by ISG

From Phase-Oriented Sequential and Manual Development ...



... To Incremental and Automated System Generation



Case Study On Comparison of ISG with Standard Lifcycle

- Example: embedded system for process control
  - estimation derived from experience by real project
  - estimation according to the currently applied phased lifecycle
  - estimation according to ISG approach
- Phased lifecycle
  - costs: 750 kEuro (1.5 Mio DM)
  - duration: 30 months
- ISG lifecycle
  - costs: 450 kEuro (900 TDM)
  - duration: 18 months
- Savings
  - costs: 300 kEuro (600 TDM) = 40%
  - duration: 12 months = 40%
- + Risk Reduction

Characterisation of Application (1/2)

- embedded system
  - two processors (Sparc)
  - real-time operating system (VxWorks)
  - C language
  - a number of peripherals
    - motor drives
    - pumps
    - heaters
    - sensors
  - command and monitoring interface by links
  - application software
    - combination of asynchronous and synchronous processing

      synchronously: actuator control

      asynchronously: commanding, exception handling, timeline execution
    - critical resources (memory, CPU power)

Characterisation of Application (2/2)

- application software (c'td)
  - about 40 SW real-time processes according to architectural design
  - about 30 SW processes at the end after optimisation
- re-structurisation needed for performance tuning
  - database: to tune data storage and retrieval
  - data packaging: to tune data calibration and generation of monitoring packages
- change of commanding interface requested

❒ development environment

- Unix / Solaris host
- cross compilation

❒ target platforms

- two platforms
- equivalent processors (Sparc)

  but different hardware

ISG Development Approach

- development and pre-"verification & validation" on Unix host
- transparent platform support
  - possibility to move easily from platform to platform
    - platform configuration only requires change of switches
    - support of heterogneous partitioning
  - map application software onto a mix of platforms
    development platform, platform 1 and 2
- ISG approach applied to application software
  - database software
  - data acquisition + calibration software
  - monitoring software
  - commanding software
- problem solving
  - easy database re-structurisation (about ½ day)
  - easy adaption to changed commanding interface
  - easy re-structurisation of process architecture

ISG Generation Figures

- generation of application
  - about 2 hours for distributed real-time infrastructure
    - 40 processes
    - 2 target processors
    - complete distributed real-time environment
    - checks on correctness and completness of inputs
    - about 150 external commands
    - about 500 internal command entries
    - automated integration of user-provided software
  - about 1 hour for database software
    - about 600 data items (most of them allocated to hardware interfaces)
    - for each data item a function for
      calaibration, limit monitoring
  - input for generation taken from spreadsheets (formsheets)

Remarks on Estimation

- estimation
  - does not represent project figures
  - is derived from experience gained during a project
- scheduling of refinement iterations
  - graphics are generate by MS-Project
  - MS-Project does not well support ISG iterations during refinement
    - modelling of iterations as recurring tasks conflicts with resource levelling
    - in consequence, parallel ISG iteration activities had to be linked sequentially
- significant amount of application software is still manually coded
  - firmware
  - hardware interfaces (sensors, actuators)
  - this limits the savings which can be obtained by ISG

Resource Assumptions

- team
  - two engineers (assumed labour rate: Euro 100/h or DM 200/h)
  - engineer A:
    responsible for
    - project management
    - requirements, design, integration
    - software of higher hierarchy levels
    - engineer A is applying ISG, only
  - engineer B:
    responsible for
    - hardware-related software
    - hardware-software interfaces
    - firmware
- low-level software is not covered by ISG (as done by engineer B)
  - firmware, software interfacing with hardware
  - this part has been fixed for both cases

Remarks on Savings

- savings are mainly related to
  - less effort and knowledge regarding
    - OS
    - network and distribution services, management of distribution
  - little effort regarding
    - re-structuring of database

      in fact, this could be done during an afternnon because only group numbers need to be changed
    - re-building of functions related to calibration and monitoring
  - less effort for adaption of commanding

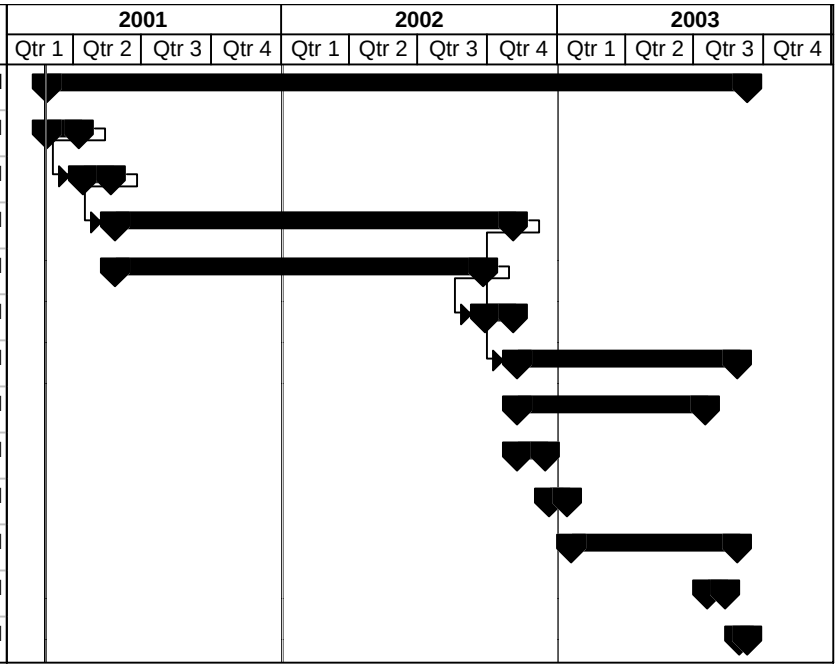
    no (C) source code has to be changed
  - less effort for test planning, execution and evaluation
  - little effort for porting of the application from platform to platform

- savings would be higher
  - if ISG would be applied to all of the project's software

    i.e. if firmware and hardware-related software would be subject of ISG, too
  - if no overhead would occur due to mix of phased and ISG lifecycle

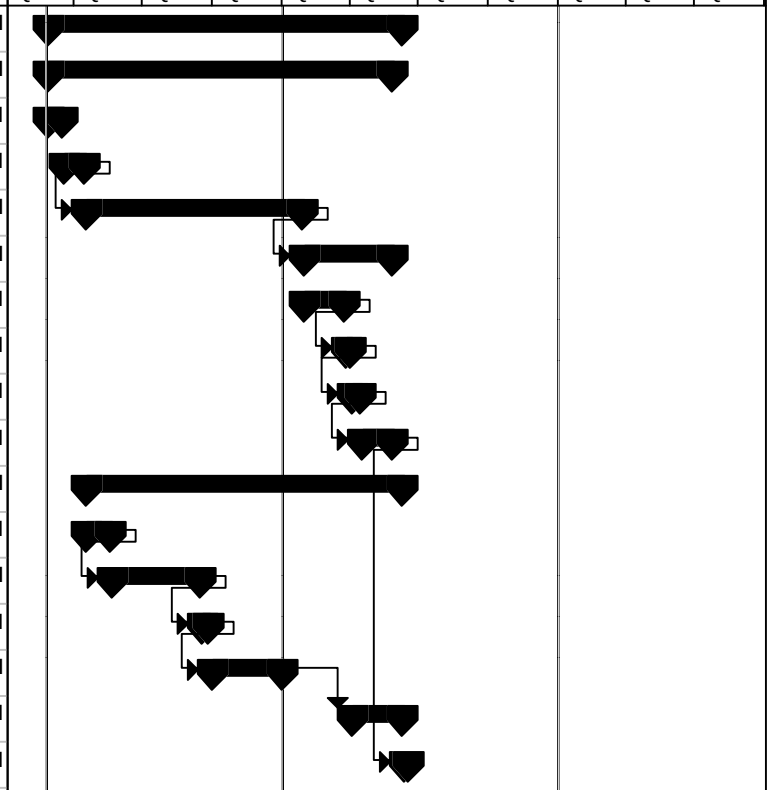
Phased Lifcycle (Summary)

ID	Task Name	Total Cost
1	Phased Lifecycle	1.448.000,00 DM
2	Requirements	56.000,00 DM
6	Design	48.000,00 DM
9	Coding	800.000,00 DM
10	Application Coding	720.000,00 DM
20	Platform Adaption	80.000,00 DM
23	Test & Integration	528.000,00 DM
24	Testing	160.000,00 DM
27	Platform Testing	80.000,00 DM
30	Doc Changes	32.000,00 DM
33	Code Changes	288.000,00 DM
41	Test Report	48.000,00 DM
45	Acceptance	16.000,00 DM



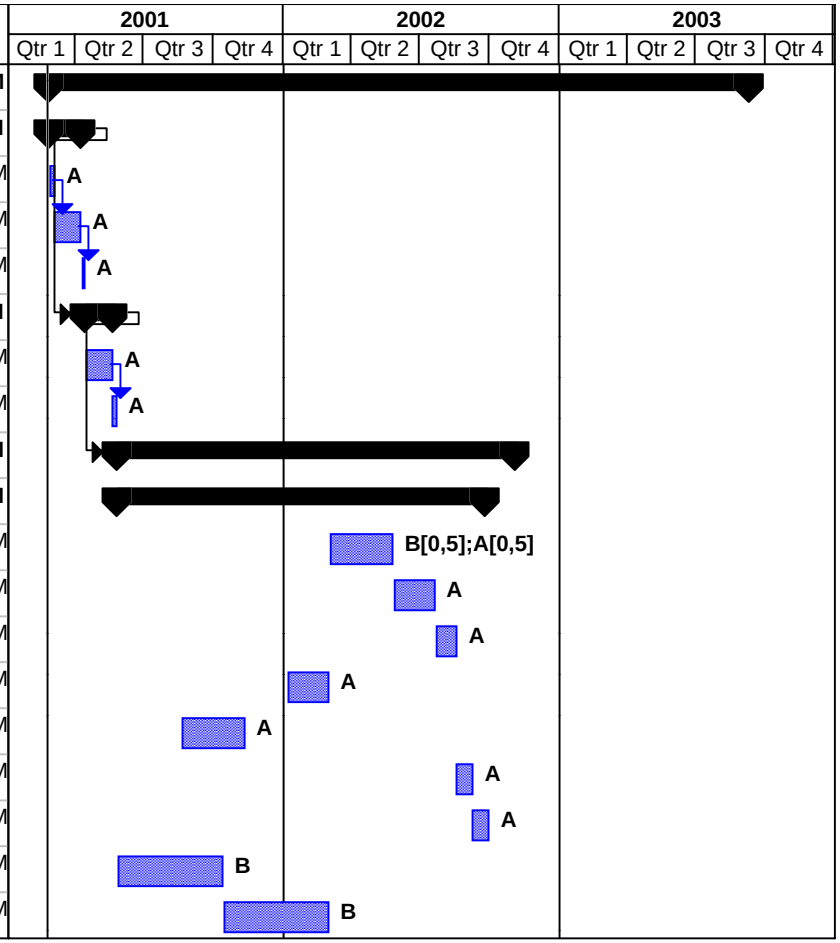
ISG Lifcycle (Summary)

ID	Task Name	Total Cost
1	ISG Lifecycle	866.400,00 DM
2	Application Specific Software	541.600,00 DM
3	Requirements	25.600,00 DM
7	Design	32.000,00 DM
10	Coding	332.000,00 DM
14	Test & Integration	152.000,00 DM
16	Platform Testing	64.000,00 DM
19	Doc. Changes	16.000,00 DM
22	Code Changes	16.000,00 DM
24	Test Report	40.000,00 DM
28	ISG Activities	324.800,00 DM
29	Requirments & Design	40.000,00 DM
33	ISG Generic Application Software	136.000,00 DM
39	ISG Application Configuration	14.400,00 DM
43	Continuous Refinement	110.400,00 DM
56	Test Report	24.000,00 DM
60	Acceptance	16.000,00 DM
63	Remark:	0,00 DM



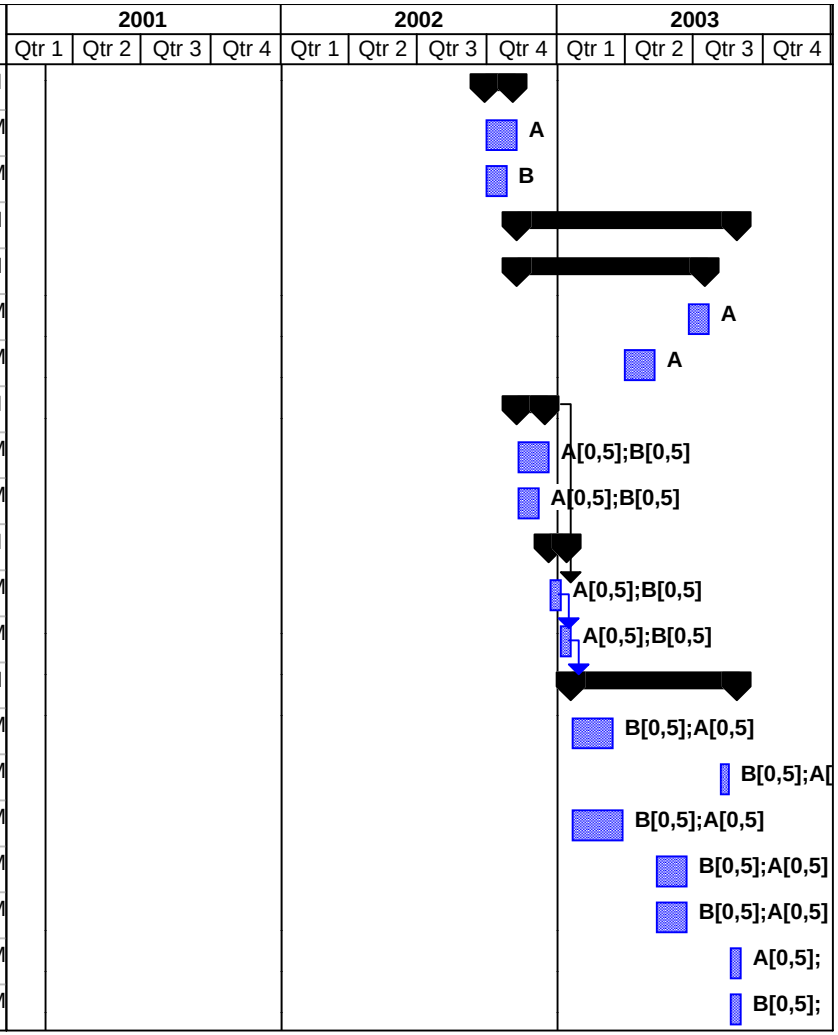
Phased Lifcycle (1/3)

ID	Task Name	Total Cost
1	**Phased Lifecycle**	**1.448.000,00 DM**
2	**Requirements**	**56.000,00 DM**
3	Requ. Capture	8.000,00 DM
4	Requ. Document	40.000,00 DM
5	Requ. Review	8.000,00 DM
6	**Design**	**48.000,00 DM**
7	Design Document	40.000,00 DM
8	Design Review	8.000,00 DM
9	**Coding**	**800.000,00 DM**
10	**Application Coding**	**720.000,00 DM**
11	OS Interfaces	96.000,00 DM
12	Network Management	64.000,00 DM
13	Exception Handling	32.000,00 DM
14	Commanding	64.000,00 DM
15	Database Management	96.000,00 DM
16	Data Processing	24.000,00 DM
17	Data Monitoring	24.000,00 DM
18	Hardware Interfaces	160.000,00 DM
19	Firmware	160.000,00 DM



Phased Lifcycle (2/3)

ID	Task Name	Total Cost
20	**Platform Adaption**	**80.000,00 DM**
21	Platform 1	48.000,00 DM
22	Platform 2	32.000,00 DM
23	**Test & Integration**	**528.000,00 DM**
24	**Testing**	**160.000,00 DM**
25	Test Plan	32.000,00 DM
26	Pre-Testing on Dev. Platform	48.000,00 DM
27	**Platform Testing**	**80.000,00 DM**
28	Platform 1	48.000,00 DM
29	Platform 2	32.000,00 DM
30	**Doc Changes**	**32.000,00 DM**
31	Requ. Changes	16.000,00 DM
32	Design Changes	16.000,00 DM
33	**Code Changes**	**288.000,00 DM**
34	Process Re-Partitioning	64.000,00 DM
35	Initialisation Procedure	16.000,00 DM
36	Database Structure	80.000,00 DM
37	Commanding	48.000,00 DM
38	Performance Optimisation	48.000,00 DM
39	Data Processing	16.000,00 DM
40	Data Monitoring	16.000,00 DM

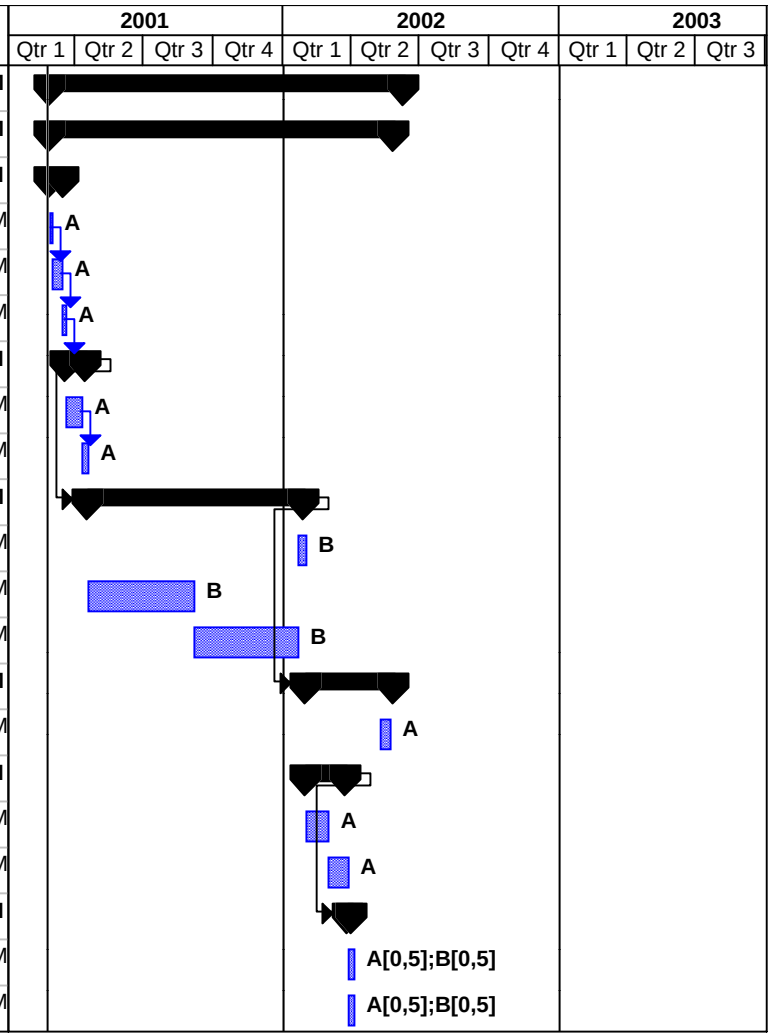


Phased Lifcycle (3/3)

ID	Task Name	Total Cost	2001 Qtr 1	2001 Qtr 2	2001 Qtr 3	2001 Qtr 4	2002 Qtr 1	2002 Qtr 2	2002 Qtr 3	2002 Qtr 4	2003 Qtr 1	2003 Qtr 2	2003 Qtr 3	2003 Qtr 4
41	**Test Report**	**48.000,00 DM**												
42	Test Report Pre-Testing	16.000,00 DM											A[0,5];B[0	
43	Test Report Platform 1	16.000,00 DM											A[0,5];B[0	
44	Test Report Platform 2	16.000,00 DM											A[0,5];B[	
45	**Acceptance**	**16.000,00 DM**												
46	Acceptance Tests	16.000,00 DM											A[0,5];	

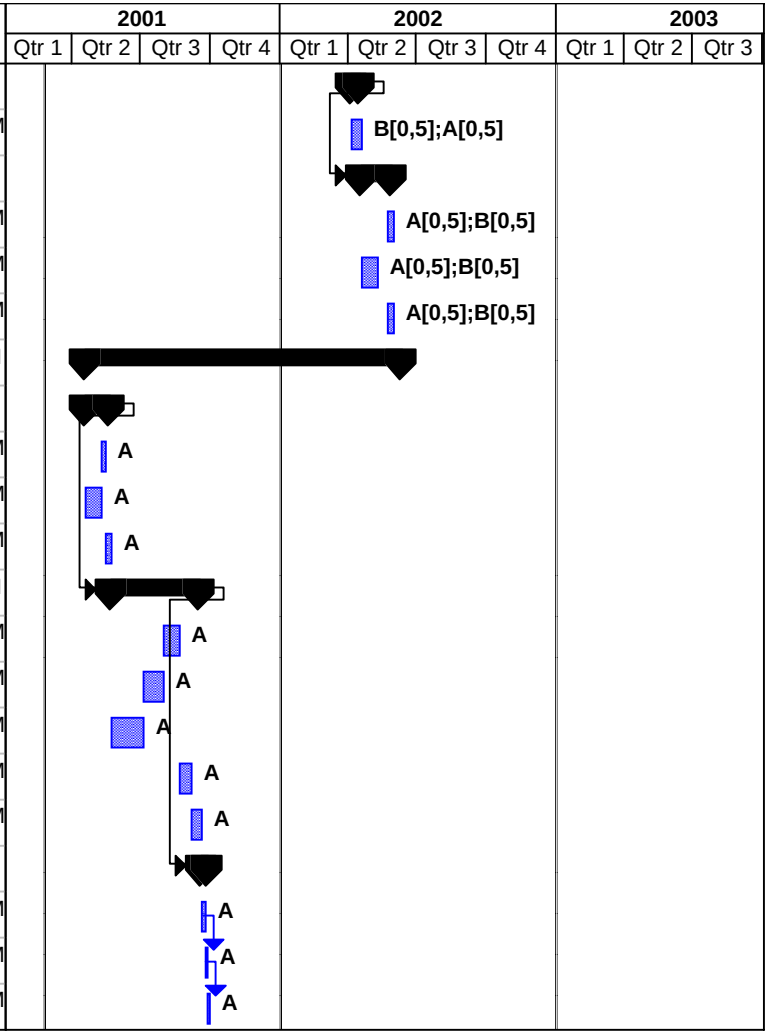
ISG Lifcycle (1/4)

ID	Task Name	Total Cost
1	**ISG Lifecycle**	**866.400,00 DM**
2	**Application Specific Software**	**541.600,00 DM**
3	**Requirements**	**25.600,00 DM**
4	Requ. Capture	4.800,00 DM
5	Requ. Document	16.000,00 DM
6	Requ. Review	4.800,00 DM
7	**Design**	**32.000,00 DM**
8	Design Document	24.000,00 DM
9	Design Review	8.000,00 DM
10	**Coding**	**332.000,00 DM**
11	OS Interfaces	12.000,00 DM
12	Hardware Interfaces	160.000,00 DM
13	Firmware	160.000,00 DM
14	**Test & Integration**	**152.000,00 DM**
15	Test Plan	16.000,00 DM
16	**Platform Testing**	**64.000,00 DM**
17	Platform 1	32.000,00 DM
18	Platform 2	32.000,00 DM
19	**Doc. Changes**	**16.000,00 DM**
20	Requ. Changes	8.000,00 DM
21	Design Changes	8.000,00 DM



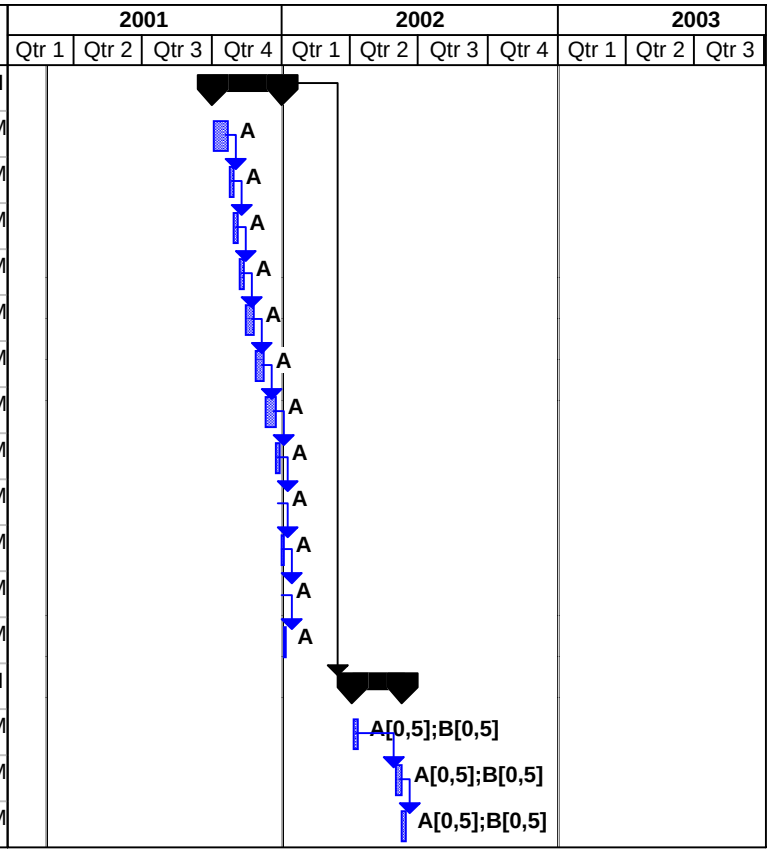
ISG Lifcycle (2/4)

ID	Task Name	Total Cost
22	**Code Changes**	**16.000,00 DM**
23	Interfaces	16.000,00 DM
24	**Test Report**	**40.000,00 DM**
25	Test Report Pre-Testing	8.000,00 DM
26	Test Report Platform 1	24.000,00 DM
27	Test Report Platform 2	8.000,00 DM
28	**ISG Activities**	**324.800,00 DM**
29	**Requirments & Design**	**40.000,00 DM**
30	ISG Inputs	8.000,00 DM
31	Documents	24.000,00 DM
32	Reviews	8.000,00 DM
33	**ISG Generic Application Software**	**136.000,00 DM**
34	Exception Handling	24.000,00 DM
35	Commanding	32.000,00 DM
36	Database Management	48.000,00 DM
37	Data Processing	16.000,00 DM
38	Data Monitoring	16.000,00 DM
39	**ISG Application Configuration**	**14.400,00 DM**
40	OS Interfaces	8.000,00 DM
41	Network Management	3.200,00 DM
42	Test Plan	3.200,00 DM



ISG Lifcycle (3/4)

ID	Task Name	Total Cost
43	**Continuous Refinement**	**110.400,00 DM**
44	Exception Handling	24.000,00 DM
45	Commanding	8.000,00 DM
46	Database Mangement	8.000,00 DM
47	Data Processing	8.000,00 DM
48	Data Monitoring	16.000,00 DM
49	Testing Development Platform	16.000,00 DM
50	Testing Platform 1	16.000,00 DM
51	Testing Platform 2	4.800,00 DM
52	Requ. Changes	3.200,00 DM
53	Design Changes	3.200,00 DM
54	Re-Partitioning	1.600,00 DM
55	Change Initialisation	1.600,00 DM
56	**Test Report**	**24.000,00 DM**
57	Development Platform	8.000,00 DM
58	Platform 1	8.000,00 DM
59	Platform 2	8.000,00 DM



ISG Lifcycle (4/4)

ID	Task Name	Total Cost	2001				2002				2003		
			Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3
60	**Acceptance**	**16.000,00 DM**											
61	Acceptance Tests	8.000,00 DM											
62													
63	**Remark:**	**0,00 DM**											
64	**Tasks of "Continuous refinement" shall run**	0,00 DM											
65	**in parallel, BUT MS-project does not allow**	0,00 DM											
66	**to do it !!!!**	0,00 DM											
67	**Also, task "Generic Application SW"**	0,00 DM											
68	**shall run in parallel to**	0,00 DM											
69	**"Continuous Refinement"**	0,00 DM											