Customer Scenarios:

Scenario Refinement for Scenario #1		
Scenario(s):		When a Pulse Generator senses an abnormal decrease in the heart rate, it starts generating pulses in less than one millisecond.
Business Goals:		
Relevant Quality Attributes:		Reliability, Functionality (or Performance)
Scenario Components	Stimulus:	The heart rate of a patient decreased abnormally.
	Stimulus Source:	The patient
	Environment:	The Pulse Generator is in the process of working.
	Artifact (If Known):	Leads, Pulse Generator, Device Controller-Monitor
	Response:	The Pulse Generator starts generating pulses.
	Response Measure:	one millisecond
Questions:		What's the lowest heart rate of a patient before it is detected by the system's sensor?
Issues:		May need to train installers to avoid parameter setting errors and prevent malfunctions.

Scenario Refinement for Scenario #2		
Scenario(s):		When the battery of a Pulse Generator is about to run out, it switches working modes to extend lifespan in less than one second.
Business Goals:		
Relevant Quality Attributes:		Usability, Cost-saving
Scenario Components	Stimulus:	The battery of a Pulse Generator is below the critical level.
	Stimulus Source:	the Pulse Generator
	Environment:	The Device Controller is in the process of monitoring and the Pulse Generator is working.
	Artifact (If Known):	Leads, Pulse Generator, Device Controller-Monitor
	Response:	The Pulse Generator switches its working mode into a low-power status.
	Response Measure:	One second
Questions:		What's the lowest battery could a Pulse Generator be before it switches working modes to maintain essential functional requirements?
Issues:		Patients may need to detect the operating states of battery and relevant components in hospital termly.

Developer Scenarios:

Scenario Refinement for Scenario #3		
Scenario(s):		When a developer adds the support of DDDR model to the system, it should be accurate and doesn't influence other functions.
Business Goals:		
Relevant Quality Attributes:		Maintainability, Modifiability
Scenario Components	Stimulus:	add the support of DDDR model to the system
	Stimulus Source:	developer
	Environment:	design-time, develop time
	Artifact (If Known):	source code
	Response:	New model will be accurate, and don't influence other functions.
	Response Measure:	finish in one month
Questions:		How developers can familiar with the code quickly?
Issues:		May need perfect and effective mechanism and accurate and complete documents.

Scenario Refinement for Scenario #4		
Scenario(s):		When finishing the code of rate sensing function, The pacemaker experiences a thorough unit test.
Business Goals:		
Relevant Quality Attributes:		
Scenario Components	Stimulus:	When finishing the function of rate sensing
	Stimulus Source:	developer
	Environment:	design-time, develop-time
	Artifact (If Known):	source code
	Response:	Rate sensing passes the unit test
	Response Measure:	every 2 seconds
Questions:		What is the correct value of heart rate?
Issues:		May need a simulator to simulate human's heartbeat

Engineer Scenario:

Scenario Refinement for Scenario #5		
Scenario(s):		When the sensors sense arrhythmia, the pacemaker will record relevant data and prepared for doctor to check.
Business Goals:		Practical product; feature-rich product
Relevant Quality Attributes:		performance
Scenario Components	Stimulus:	Arrhythmia of the host
	Stimulus Source:	Pulses external to the system, irregular heartbeat
	Environment:	The pacemaker is in the standby mode.
	Artifact (If Known):	System's impulse sensor, info-logout software component
	Response:	The pacemaker records the arrhythmia information
	Response Measure:	Data in the flash
Questions:		How to distinguish arrhythmia with normal heartbeat rate changing?
Issues:		May need further information to adjust or use machine learning

Scenario Refinement for Scenario #6		
Scenario(s):		When the pacemaker itself meets system error, the pacemaker records and informs doctor about the risk
Business Goals:		Safest system, feature-rich product
Relevant Quality Attributes:		Safety, reliability
Scenario Components	Stimulus:	System errors
	Stimulus Source:	Internal errors such as software error; external errors such as not recorded pulses.
	Environment:	Anytime the pacemaker is at working
	Artifact (If Known):	System's impulse sensor, system's component checking software component
	Response:	The pacemaker record and inform the doctor about the risk
	Response Measure:	Data in the flash & data uploaded to the doctor
Questions:		How to determine whether errors come from external factors or internal factors?
Issues:		May need extra sensors for error detection.

Product Manager Scenarios:

Scenario Refinement for Scenario #7		
Scenario(s):		When the system detects that the pacemaker doesn't work properly, it will try to recover or switch to backup system and give patient alerts.
Business Goals:		Safest device, feature-rich
Relevant Quality Attributes:		Safety, availability
Scenario Components	Stimulus:	Malfunctions, including low-battery, problems with detecting intra cardiac signals
	Stimulus Source:	Main functional parts of the pacemaker
	Environment:	The error handler is monitoring the status of other parts
	Artifact (If Known):	Error handler
	Response:	Try to recover or switch to backup system and give alerts
	Response Measure:	Less than one second
Questions:		How long at least should the backup system work properly before doctors fix the problem?
Issues:		Need to tell patients avoid potential dangerous situation and teach them how to recognize the meaning of different notifications.
Scenario Refinement for Scenario #8		
Scenario(s):		When you want to add some functions, or replace some units (like battery) of the device, you can do it easily and keep/reuse most parts from the original device.
Business Goals:		Resource economy, maintainability
Relevant Quality Attributes:		Reusability, portability
Scenario Components	Stimulus:	When you want to add some functions, or replace some units.
	Stimulus Source:	New feature requirement or equipment maintenance
	Environment:	Normal operation
	Artifact (If Known):	Technicians, human operator
	Response:	Make modification without side effect, deploy it with minimal effort
	Response Measure:	Extent of effort/cost
Questions:		What's the specific parameter requirement for different units of the device?
Issues:		The technician must the life cycle of each unit of the device.

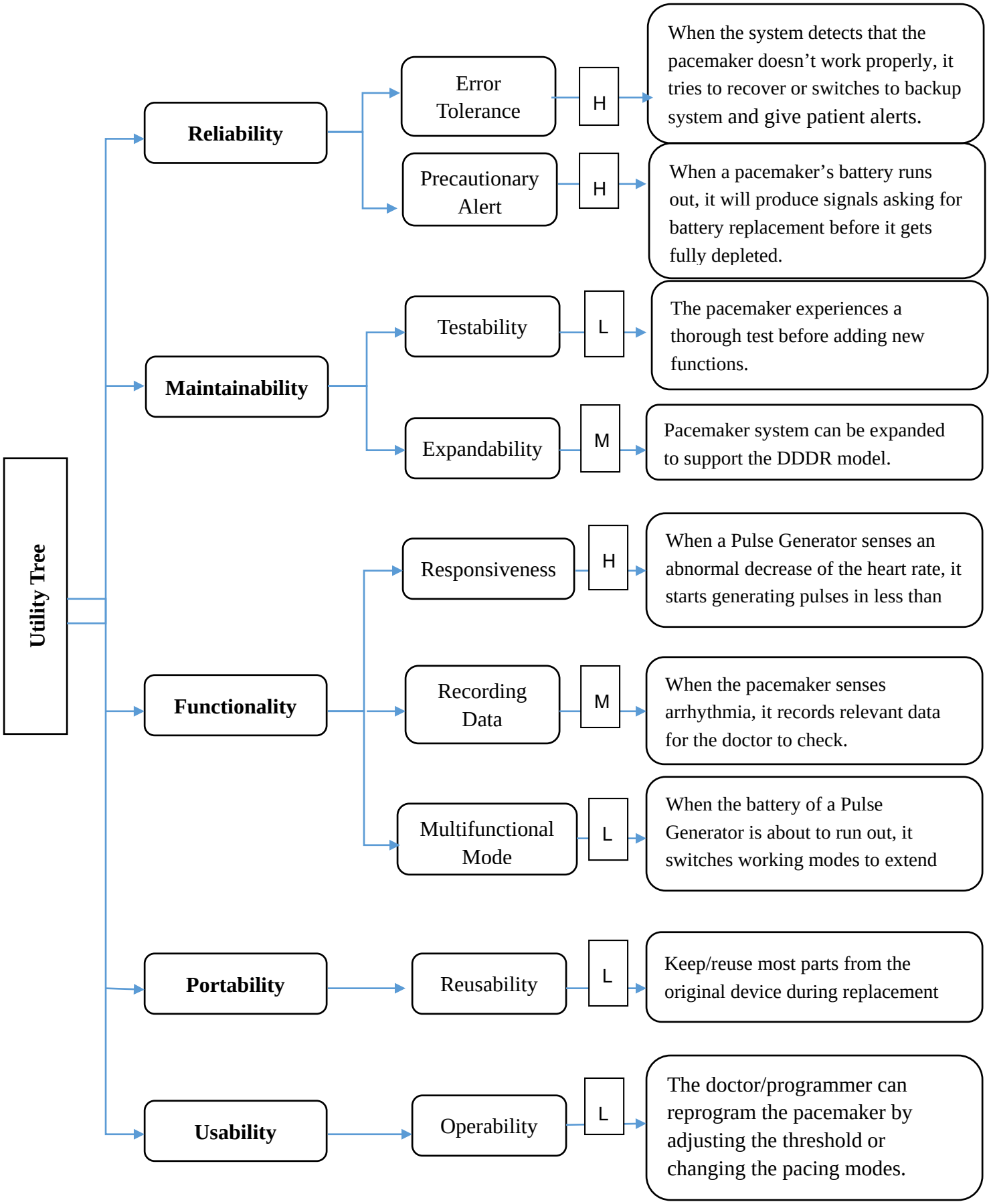
Maintainer Scenarios:

Scenario Refinement for Scenario #9		
Scenario(s):		When a patient experiences irregular beating from the pacemaker, the doctor/programmer can reprogram the pacemaker by adjusting the threshold or changing the pacing modes.
Business Goals:		feature-rich product, smart system
Relevant Quality Attributes:		Maintainability
Scenario Components	Stimulus:	Patients experience irregular beating from the pacemaker.
	Stimulus Source:	Problems with sensing including undersensing or oversensing; problems with output including output failure or failure to capture.
	Environment:	Pacemaker is implanted in the patient's body
	Artifact (If Known):	
	Response:	The pacemaker has a reprogramming functionality allows
	Response Measure:	As needed
Questions:		How is the pacing modes related to the irregular beating?
Issues:		The doctor meets with patients every 6 months for regular check and responses to patients immediately as requested

Scenario Refinement for Scenario #10		
Scenario(s):		When a pacemaker's battery runs out, it will produce signals asking for battery replacement before it gets fully depleted.
Business Goals:		Safest system, smart system
Relevant Quality Attributes:		Maintainability, Reliability
Scenario Components	Stimulus:	A pacemaker's battery becomes depleted
	Stimulus Source:	Pacemaker's battery
	Environment:	The pacemaker is implanted in the patient's body
	Artifact (If Known):	
	Response:	The pacemaker sends out signals for replacement
	Response Measure:	As soon as the battery life is below the warning threshold
Questions:		How long should the battery keep working after sending out signals?
Issues:		The battery life should be checked during the regular follow-up care.

Member	Votes
Product Manager (Yang Guo)	Each one have 2 votes of two rounds, that is totally 4 votes per member
Customer (Yang Cao)	
Engineer (Jingbei Liu)	
Developer (Jinrui Wang)	
Maintainer (Yuan Gao)	

Scenario#	Description	Votes
#1	When a Pulse Generator senses an abnormal decrease of the heart rate, it starts generating pulses in less than one millisecond.	4
#2	When the battery of a Pulse Generator is about to run out, it switches working modes to extend lifespan in less than one second.	1
#3	When a developer wants to add the support of DDDR model to the system, it could be accurate and don't influence other functions.	2
#4	When finish the code of rate sensing function, we should also write a unit test.	0
#5	When the sensors sense arrhythmia, the pacemaker will record relevant data and prepared for doctor to check.	2
#6	When the pacemaker itself meets system error, the pacemaker records and informs doctor about the risk	1
#7	When the system detects that the pacemaker doesn't work properly, it will try to recover or switch to backup system and give patient alerts.	5
#8	When you want to add some functions, or replace some units (like battery) of the device, you can do it easily and keep/reuse most parts from the original device.	1
#9	When a patient experiences irregular beating from the pacemaker, the doctor/programmer can reprogram the pacemaker by adjusting the threshold or changing the pacing modes.	1
#10	When a pacemaker's battery runs out, it will produce signals asking for battery replacement before it gets fully depleted.	3


Utility Tree
Reliability
Error Tolerance
H
When the system detects that the pacemaker doesn't work properly, it tries to recover or switches to backup system and give patient alerts.
Precautionary Alert
H
When a pacemaker's battery runs out, it will produce signals asking for battery replacement before it gets fully depleted.
Maintainability
Testability
L
The pacemaker experiences a thorough test before adding new functions.
Expandability
M
Pacemaker system can be expanded to support the DDDR model.
Functionality
Responsiveness
H
When a Pulse Generator senses an abnormal decrease of the heart rate, it starts generating pulses in less than
Recording Data
M
When the pacemaker senses arrhythmia, it records relevant data for the doctor to check.
Multifunctional Mode
L
When the battery of a Pulse Generator is about to run out, it switches working modes to extend
Portability
Reusability
L
Keep/reuse most parts from the original device during replacement
Usability
Operability
L
The doctor/programmer can reprogram the pacemaker by adjusting the threshold or changing the pacing modes.